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ACRONYMS AND ABBREVIATIONS

AMW	all monitored worker
CTW	construction trade worker
dpm	disintegrations per minute
GM	geometric mean
GSD	geometric standard deviation
ID	identification
L	liter
MCPT	Monte Carlo permutation test
MPM	maximum possible mean
NIOSH	National Institute for Occupational Safety and Health
NOCTS	NIOSH Claims Tracking System
OPOS	one person – one sample
ORAU	Oak Ridge Associated Universities
QA	quality assurance
ROS	regression on order statistics
SRDB Ref ID	Site Research Database Reference Identification (number)
SRS	Savannah River Site
TLD	thermoluminescent dosimeter
unk	unknown

1.0 INTRODUCTION

At the Savannah River Site (SRS), some workers might have been exposed to exotic trivalent radionuclides without being monitored for that potential exposure. The National Institute for Occupational Safety and Health (NIOSH) Dose Reconstruction Project uses coworker models to estimate doses for workers who were not monitored for exposure to radioactive materials but may have been exposed to radioactive materials (ORAUT 2007, p. 13). Such a dose is referred to as *unmonitored dose*. Coworker models are typically constructed using data from all monitored workers by fitting a lognormal probability distribution to the data (ORAUT 2005, 2006) to estimate the geometric mean (GM) and geometric standard deviation (GSD) of the doses. Coworker models for external dose are usually constructed from external doses assigned to individuals with film badges and thermoluminescent dosimeters (TLDs). Coworker models for internal dose are calculated using bioassay data that are later evaluated in terms of chronic intake rates and, ultimately, internal doses.

Rather than using all monitored workers to construct a coworker model, an analysis can stratify monitored workers into subgroups (i.e., strata) and construct separate coworker models for each stratum. Stratification offers potential advantages, such as more precise estimates of the dose to unmonitored workers in a stratum, but it also has a number of potential drawbacks and limitations (ORAUT 2010). The purpose of this report is to evaluate two proposed strata in relation to bioassay data, potential intakes, and internal doses from exotic trivalent radionuclides. The two strata consist of (1) the construction trade worker (CTW) stratum that includes workers classified as CTWs in accordance with ORAUT-OTIB-0052 (ORAUT 2011) and (2) the nonCTW stratum that includes workers not classified as CTWs (non-construction trade workers). A statistically and practically significant difference between the CTW and nonCTW strata could warrant coworker models based on the individual strata rather than the entire population of monitored workers, designated as the all monitored workers (AMWs) in this document.

This evaluation includes a third stratum of workers whose job classifications are not available or unknown (abbreviated as “unk”). This is different from the application of OTIB-0052 (ORAUT 2011) during performance of dose reconstructions where individuals are not considered to be CTWs unless there is a reason to classify them as such. In this analysis, the unks are evaluated in two manners: 1) they are included with the nonCTWs, and 2) they are excluded entirely from the strata comparison. Exclusion from the strata comparison is the difference from the normal application of OTIB-0052. The distinction is made for this report because less information is available about all the workers with exotic trivalent radionuclides bioassay data than is available for energy employees whose dose is being reconstructed. For energy employees whose dose is being reconstructed, individual-specific information is available from the DOE records, the record of the telephone interview, and information provided by the DOL.

2.0 BIOASSAY DATA VERSUS DOSE

Monitoring for workers who have the potential for exposure to external radiation typically consists of a dosimeter (e.g., TLD or film badge) they wear on the upper torso of the body. The dosimeter indicates the cumulative dose to the whole body that is received between readings of the dosimeter, which creates monitoring intervals that can be anywhere from days to months in duration. A key property of the reported doses for each interval is that, for a given individual, the doses are statistically independent of each other. For example, the received dose in a given month, by itself, provides no information about the dose in the next month and, similarly, the received dose in a given year, by itself, provides no information about the dose in the next year.

Internal dose monitoring programs are in many ways similar to the above-described external dose programs, but internal dose programs tend to be based on bioassay rather than dosimeters. This is an important difference because, if an individual has an intake of radioactive material such that radioactive material is detected in given sample, subsequent bioassay samples can also have detectable radioactivity even if there have been no additional intakes. This means bioassay results can correlate with each other and are no longer statistically independent. This correlation can exist for a brief period (after a small intake of tritium, for example), or for the length of a career (after a large intake of plutonium, for example). For exotic trivalent radionuclides, this correlation may hold for a period of a few months to a couple years.

Operational bioassay programs can generate multiple results for an individual in a given period (e.g., a year), which creates a related problem if an individual is involved in an incident and has more (potentially many more) bioassay results than other workers. If these are not accounted for, the problems of correlated data and unequal numbers of samples per person can skew evaluation of the data by unequally weighting data from that individual. The solution to this problem is to generate a single statistic that characterizes multiple bioassay results for each person in a given period. This is referred to as a *one person – one sample* (OPOS) statistic. The OPOS statistic is calculated using the maximum possible mean (MPM) methodology (ORAUT 2012).

3.0 METHODOLOGY

The CTW and nonCTW strata were compared using the methodology from ORAUT-RPRT-0053 (ORAUT 2012). The basic steps of this methodology, discussed in more detail below, are:

- Evaluate the complete set of exotic trivalent radionuclides bioassay data and determine the job classification (CTW, nonCTW, or unk) for each individual for each bioassay sample.
- For each individual and each time period, determine the OPOS statistic for the AMW, CTW, and nonCTW strata, and for the combined nonCTW+unk stratum (See Section 3.3 for more detail).
- Determine the GM and GSD urinary excretion rates for the AMW, CTW, nonCTW, and combined nonCTW+unk strata for each time period using the regression on order statistics (ROS), effective fit, and binomial methods (ORAUT 2012) as appropriate.
- Compare the CTW:nonCTW and CTW:nonCTW+unk strata using the Monte Carlo permutation test (MCPT) and Peto-Prentice tests (ORAUT 2012) to determine if there is a statistically significant difference.
- If there is a statistically significant difference, compare the CTW:nonCTW and CTW:nonCTW+unk strata to determine if there is a practical difference.

At Savannah River, all personnel working in regulated areas (“Regulated Zones” and “Radiation Danger Zones”), including construction workers, were periodically checked for assimilation of radioactive material by urinalysis bioassay (DuPont 1961). The only exception to this may have been when special exclusion zones were established, and when this occurred, the outer boundaries of the radiological areas were monitored (ORAUT 2008). Notification of sample request was given to employees through their supervision. Special bioassay samples were requested of workers, including construction workers, by Health Physics through the worker’s supervision, when a potential assimilation of radioactive material was suspected through air or surface contamination monitoring (DuPont 1961).

CTWs are potentially subject to different bioassay practices than other workers. CTWs, many of whom are contractors, commonly submit bioassay samples after suspected uptakes and at the completion of jobs. This is in contrast to other workers, especially those employed directly by the prime contractor, who are more likely to be on a routine bioassay program in addition to submitting bioassay samples after suspected uptakes. A post-job bioassay is more likely to be soon after an unknown uptake than is a routine bioassay sample and thus would be higher. This potential difference in how the strata are monitored for intakes would result in higher results for CTWs compared to the other strata.

3.1 EXOTIC TRIVALENT RADIONUCLIDES BIOASSAY DATA

Exotic trivalent radionuclides bioassay data were obtained from SRS hard-copy laboratory notebooks (DuPont 1963–1970, 1969–1973, 1970–1973, 1973–1978, 1973–1979, 1978–1983, 1979–1980, 1980–1981a,b, 1981–1986, 1986–1989). The data were transferred to a spreadsheet and subjected to a quality assurance (QA) verification in accordance with MIL-STD-105E, *Sampling Procedures and Tables for Inspection by Attributes* (DOD 1989). 315 records were randomly picked and reviewed for accuracy of the data transcription. The first round of verification identified generic issues, which were corrected, and a second round of verification was performed that indicated an acceptable error rate. In the second round, 15 errors were identified, 7 of which were classified as critical errors, i.e., errors which would impact subsequent data analysis. 7 errors out of a sample of 315 records equates to a 1% error rate in the full data set. The errors that were identified during the QA process were corrected. In addition, other errors were discovered during subsequent statistical analyses of the data, usually as a result of identification of outliers in the dataset. The most common error was omission of the decimal due to legibility issues, resulting in higher than actual bioassay results. These corrections were made and documented before further analysis.

The analysis assumes the data form a complete dataset of all exotic trivalent radionuclides monitoring during the relevant periods. A single urine sample was commonly counted multiple times, usually twice but up to 10 times was noted. The data in the logbooks consisted of one or more count rate results for each urine sample in units of dpm per disc dependent on how many times a sample was counted (this information was not used) and count-specific results in units of net dpm/1.5 L (this information was used). Further, a reported value for each sample, also in units of dpm/1.5 L, was usually provided. The result in dpm/1.5 L for each count of a sample was generally recorded as an uncensored value, i.e. the calculated result was recorded regardless of its value. In contrast, the “reported” values were generally censored, i.e., results less than some level, typically the detection or reporting limit were reported as a “less than” result. Some dpm/1.5 L data that were less than zero were reported as zero.

Not all sample records included all this information, and in some instances the count-specific results were censored. If count-specific results were available, the valid results were averaged by the ORAU Team to determine the sample result. This value was generally uncensored. If count-specific results were not available, the reported value was used, many of which were censored. Excluded samples included those marked as “LIP” for Lost In Process, those marked “DTPA” to indicate chelation, or those that lacked sufficient identifying information [e.g., sample date or worker identification (ID) number].

Three sample results were excluded as false positives because the subsequent samples had no detected activity. In addition, all results for three individuals were excluded for an entire year due to an ingestion intake, a plutonium wound intake, and an incident that resulted in the highest assigned intake of ^{244}Cm in the history of SRS. These incidents and intakes were characterized by an extremely high number of bioassay results many of which were orders of magnitude higher than the bioassay data for other individuals and were considered unrepresentative of the potential exposure to an unmonitored worker.

3.2 JOB CLASSIFICATION DETERMINATION

NIOSH directed the Oak Ridge Associated Universities (ORAU) Team to use *1954 Craft Payroll Codes* (Author unknown undated) as the source of crafts and occupations and the payroll ID field to determine which workers should be assigned to the CTW stratum. NIOSH and the ORAU Team reviewed the crafts in that document and determined that the following are CTW crafts at SRS that could have involved radiological exposure. The payroll ID prefix is listed first with each of the CTW crafts:

- 02 – Instruments
- 05 – Laborer
- 06 – Carpenter
- 12 – Iron Worker
- 14 – Heavy Equipment Operator
- 15 – Steelworker
- 18 – Millwright
- 20 – Boilermaker
- 21 – Sheetmetal Worker
- 25 – Electrician
- 26 – Pipefitter
- 31 – Insulator
- 33 – Painter

In addition, NIOSH and the ORAU Team considered any worker in Payroll Roll #2 (which is different from payroll prefix 02 in the list above) with one of the craft (occupational title) listings above to be a CTW. An additional craft code, 17, was not given in *1954 Craft Payroll Codes* but was determined to be associated with “Painter” from examination of SRS work history data. The worker history cards were reviewed to determine the payroll ID# and/or occupational title for each individual for each bioassay result. The last entry on the worker history card prior to the date of the bioassay sample was used to determine the payroll ID# and/or occupational title.

The following steps were used to identify CTW, nonCTW, and unk data. For each bioassay record, the ORAU Team using the sample date, name and payroll id (PR ID), retrieved the assigned job/occupational title from the SRS work history card (O:\DOE Site Images\Savannah River\Work History Information\EDAR & WkHx Images) matched to the sampled worker and for the sampled date since a worker could have multiple occupational titles over time. In some instances, the value of the PR ID field was different on the card than in the bioassay file and were changed. Occupational titles were recorded as stated on the card. When either the personal information could not be found in the SRS worker history cards or when an occupational title was not recorded on the matched card, an entry of unknown was recorded in the Occupational Title field. Once occupational titles had been queried for all bioassay records, various instances of the same high-level occupational title were made consistent and recorded in the Changed Occupational Title field. For example, Research Chemist and Junior Chemist were considered to be Chemist. The values of two fields, “Changed Payroll ID#” and “Changed Occupational Title,” were used to denote the value of the CTW field in that particular row. The name of these fields includes “changed” to distinguish them from the original payroll ID# and occupation title fields. The “changed Payroll ID #” field reformats the originally-recorded payroll ID#’s into a consistent format (hyphens, leading zeros, etc.) while retaining the originally recorded number. No distinction was made between DuPont workers and non-DuPont workers.

If the Changed Payroll ID# was of the form “XX-ppppp” where “XX” is 05, 06, 12, 14, 15, 17, 18, 20, 21, 25, 26, 31, or 33 and “ppppp” is a 5- or more digit number, the record was treated as that of a CTW.

If the Changed Payroll ID# was of the form “T-nnnn” where “nnnn” is a number, the record was treated as that of a nonCTW. [Payroll IDs starting with “T-“ indicate payroll 1, which did not apply to CTWs.]

If the Changed Payroll ID# was of the form “mmmmm” where “mmmmm” is a 2-, 3-, 4-, or 5-digit number only, the value of Changed Occupational Title was checked.

If the Changed Occupational Title was “Boilermaker,” “Carpenter,” “CTW,” “Electrician,” “Glass Blower,” “Heavy Equipment Operator,” “Helper,” “Laborer,” “Maintenance,” “Mechanic,” “Millwright,” “Painter,” or “Rigger,” the record was treated as that of a CTW.

If the Changed Occupational Title was “Roll 2”, “unknown,” or null, the value of CTW was set to “unk.”

For all remaining rows, the record was treated as that of a nonCTW.

All remaining records were treated as unk.

This classification process was refined using data from the NIOSH Claims Tracking System (NOCTS). NOCTS was searched for individuals classified as unk. If the person was found, the NOCTS description of that person’s job title was used to classify the person using the same basic methodology as that in step 3 above.

3.3 ONE PERSON – ONE SAMPLE STATISTIC

An average bioassay result using the MPM method was determined for each individual for each evaluated time period and each job category. This resulted in a table of OPOS results for all workers (AMW) that used all available bioassay data and three other tables for the CTW, nonCTW, and nonCTW+unk strata that used only bioassay data identified as belonging to each of those strata. Because it was possible for a worker to change jobs during the course of a single evaluated time period, it is possible that a worker would have some samples identified as nonCTW and others as CTW in the same time period. Therefore, one person might have as many as four different OPOS results, one each for the AMW, CTW, nonCTW, and nonCTW+unk strata. Table 3-1 lists the number of total bioassay results and number of OPOS results for AMW and each strata.

Table 3-2 details the percentage of occurrences of multiple bioassay results averaged using the MPM method for each strata. More multi-year time periods were used for the CTW, nonCTW, and nonCTW+unk strata, which results in a higher percentage of occurrences of 2 bioassay results per time period and a lower percentage of 1 bioassay result compared to the AMWs.

Table 3-3 lists the ratio of CTWs and nonCTWs+unks that received bioassay monitoring for exotic trivalent radionuclides for each year in the 1973 through 1981 time period. The number of manufacturing and technical workers (assumed to represent the nonCTWs+unks) and the number of construction workers is based on the SRS monthly report abstracts prepared by Taulbee (2011) using the number of manufacturing, technical, and construction workers summarized for July of each year. There is no significant difference between the population and bioassay monitoring ratios for the two groups, which is consistent with the implementation of the same radiological monitoring procedures for the two groups.

Table 3-1. Number of total bioassay and OPOS results per time period per strata.

	AMW		CTW		nonCTW		nonCTW+unk	
Period	Total results	OPOS results	Total results	OPOS results	Total results	OPOS results	Total results	OPOS results
1966	281	155	N/A[a]	N/A[a]	N/A[a]	N/A[a]	N/A[a]	N/A[a]
1967	298	227	N/A[a]	N/A[a]	N/A[a]	N/A[a]	N/A[a]	N/A[a]
1968	766	364	N/A[a]	N/A[a]	N/A[a]	N/A[a]	N/A[a]	N/A[a]
1966–1968	N/A[b]	N/A[b]	240	101	1,071	329	1,105	343
1969	893	379	230	95	645	277	663	285
1970	1,955	567	328	124	1,593	451	1,627	461
1971	1,856	663	292	107	1,545	550	1,564	559
1972	1,565	650	208	109	1,312	525	1,357	541
1973	1,249	644	243	115	969	509	1,006	530
1974	1,067	456	162	86	876	357	905	371
1975	831	467	173	94	628	356	658	375
1976	695	450	148	90	523	346	547	360
1977	478	383	87	68	368	292	391	315
1978	306	228	66	49	232	171	240	179
1979	441	322	79	67	337	234	362	255
1980	253	230	44	42	198	178	209	188
1981	341	267	N/A[a]	N/A[a]	N/A[a]	N/A[a]	N/A[a]	N/A[a]
1982	325	307	N/A[a]	N/A[a]	N/A[a]	N/A[a]	N/A[a]	N/A[a]
1981–1982	N/A[b]	N/A[b]	80	44	524	379	586	422
1983	330	303	41	39	255	232	289	264
1984	347	275	63	20	234	210	284	255
1985	340	259	42	24	266	214	298	235
1986	399	273	101	26	253	219	298	247
1987	379	305	N/A[a]	N/A[a]	N/A[a]	N/A[a]	N/A[a]	N/A[a]
1988–1989	342	288	N/A[a]	N/A[a]	N/A[a]	N/A[a]	N/A[a]	N/A[a]
1987–1989	N/A[b]	N/A[b]	65	25	598	336	656	371

a. This time period is part of a merged time period for this strata and is not reported separately.
b. This merged time period is separated into multiple time periods for this strata and is reported for each of the separate time periods instead.

Table 3-2. Percentage of multiple bioassay results per person per time period.

# Bioassay results	AMW (%)	CTW (%)	nonCTW (%)	nonCTW+unk (%)
1	59	48	55	56
2	28	36	29	29
3	7	9	7	7
>3	6	7	9	8

Table 3-3. Population and exotic trivalent radionuclides monitoring ratios.

Year	# nonCTW+unks	# CTWs	Population ratio	Bioassay ratio
1973	5,255	500	0.10	0.22
1974	5,205	600	0.12	0.23
1975	5,140	973	0.19	0.25
1976	5,407	995	0.18	0.25
1977	5,598	1,344	0.24	0.22
1978	5,944	1,973	0.33	0.27
1979	5,709	1,958	0.34	0.26
1980	6,050	1,991	0.33	0.22
1981	6,593	2,159	0.33	0.10

3.4 STATISTICAL ANALYSIS

Statistical analysis of each dataset was performed in accordance with ORAUT-RPRT-0053 (ORAUT 2012). First, each time period was evaluated using the ROS method. If this method failed or yielded an unacceptable fit, the effective fit (maximum likelihood) method was used. In some instances, both the ROS and effective fit methods were performed to evaluate which method provided a better fit to the data.

3.5 STRATA COMPARISON

For each time period, the CTW stratum was compared to both the nonCTW and nonCTW+unk strata to determine whether there were statistical differences at the 0.05 level of significance. All statistically significant differences were evaluated for practical significance. Evaluation of if there was a practically significant difference was only performed if it was determined that there was a statistically significant difference.

Practical significance is determined by comparing the constant chronic intake rates of the two strata, calculated from the 50th and 84th percentiles of OPOS data, to see if they are significantly different. The constant chronic intake rates of the two strata are slopes of regressions through the origin, so a simple *t*-test for equal slopes can be employed. If the test is significant at the 0.05 level of significance, the constant chronic intake rates of the two strata are significantly different, and separate coworker models should be used for the two strata. If the test is not significant, the constant chronic intake rates of the two strata are not significantly different, so an AMW model should be used for both the strata.

4.0 RESULTS

4.1 BIOASSAY FITTING

Two sets of comparisons were made. The first set compared the CTW and nonCTW strata. The second set compared the CTW and combined nonCTW+unk strata. The unk stratum was included with the nonCTW stratum because this was the default assumption. Workers were assumed to belong to the nonCTW stratum unless there was justification to include them in the CTW stratum.

For the AMW and each of the three stratum, the ROS fit was calculated for all time periods for which there were sufficient data (i.e., more than one uncensored result). The effective fit process from ORAUT-RPRT-0053 (ORAUT 2012) was used for all time periods with an ROS fit GSD of 6 or greater as suggested by ORAUT-RPRT-0053. However, it was observed that the effective fit process did not result in an increase in the GM and a significant reduction in the GSD for many of the time periods fit with that process, which is in contrast to the results previously experienced with other coworker studies and datasets. For time periods for which the effective fit process did not result in an increase in the GM and a substantial decrease in the GSD of the fit, the ROS fit was used as the fit method more closely based on the actual data with no imputation or inferences being made about censored results. Attachment A contains the plots of the ROS and effective fits for each stratum (including AMW).

The effective fit was used for the AMW for the 1981-to-1982 period, for the CTW stratum for the 1981-to-1982, 1984, and 1986 periods, and for the nonCTW and nonCTW+unk strata for the 1981-to-1982 period. All other time periods were fit with the ROS method.

4.2 STRATA COMPARISONS

For 1963 to 1965, there were insufficient data to perform a comparison between the strata in either comparison set. There was only one uncensored result in the CTW strata for this entire time period. Per RPRT-0053, this is insufficient data to perform a comparison. With only one uncensored value, merging of these time periods with subsequent time periods would add no information to the analysis.

The Peto-Prentice test was performed for all time periods from 1966 through 1989. To have enough data to perform the comparisons, 1966 to 1968, 1981 to 1982, and 1987 to 1989 were combined to form three merged periods. This was necessary due to the small population size of the CTW stratum. Many of the MCPT analyses produced asymmetric clouds of points that were clearly not bivariate normal and nonparametric bagplots were not adequate, so MCPT analysis is not included. Since only Peto-Prentice tests are used for strata comparison, it is appropriate to use the Holm method for multiple comparisons.

The Peto-Prentice test is used to determine whether the distribution of the OPOS bioassay data is the same in the CTW stratum and the nonCTW stratum (or the nonCTW stratum with unknowns). The result of the Peto-Prentice test is a two-sided p-value. These p-values are compared to the Holm cutoffs (ORAUT 2012) calculated for the family of tests (all the Peto-Prentice tests for a given strata comparison, in this case each of the 19 time periods) with a family-wise significance level of 0.05. If the p-value for a single test is less than its corresponding Holm cutoff value, the strata are considered different at a statistically significant level. Table 4-1 contains the results of these Peto-Prentice tests for the two comparison sets. Test results that identified a statistically significant difference are shaded. Attachment B contains the plotted results of the Peto-Prentice tests.

Table 4-1. Strata comparison.

	CTW:nonCTW		CTW:nonCTW+unk	
Period	**Peto-Prentice**	**Holm cutoff**	**Peto-Prentice**	**Holm cutoff**
1966–1968	0.3546	0.0056	0.375	0.0056
1969	0.1772	0.0036	0.1787	0.0036
1970	0.9815	0.05	0.8923	0.025
1971	0.806	0.0125	0.813	0.0125
1972	0.7692	0.01	0.7053	0.01
1973	0.3314	0.005	0.3383	0.005
1974	0.8536	0.0167	0.8684	0.0167
1975	0.5771	0.0071	0.5465	0.0071
1976	0.2562	0.0042	0.3021	0.0045
1977	0.3587	0.0062	0.4499	0.0062
1978	0.2401	0.0038	0.2186	0.0038
1979	0.9295	0.025	0.9082	0.05
1980	0.276	0.0045	0.2646	0.0042
1981–1982	0.0243	0.0029	0.0315	0.0029
1983	0.0129	0.0028	0.0074	0.0028
1984	0.1263	0.0031	0.0930	0.0031
1985	0.0006	0.0026	0.0005	0.0026
1986	0.1268	0.0033	0.1782	0.0033
1987–1989	0.6796	0.0083	0.6796	0.0083

A statistically significant difference was identified for only one year, 1985, in both the CTW:nonCTW and CTW:nonCTW+unk comparison sets. To evaluate the practical significance of this difference, the GM and 84th percentiles for each stratum (including AMW) were plotted together for comparison in Figures 4-1 and 4-2, respectively. For all strata, the overall trend of the GM is a horizontal trend line with the individual data points varying about a urinary excretion of approximately 0.01 dpm/day starting in 1973. The 84th percentile is similar, varying about a urinary excretion of approximately 0.1 dpm/day starting in 1973.

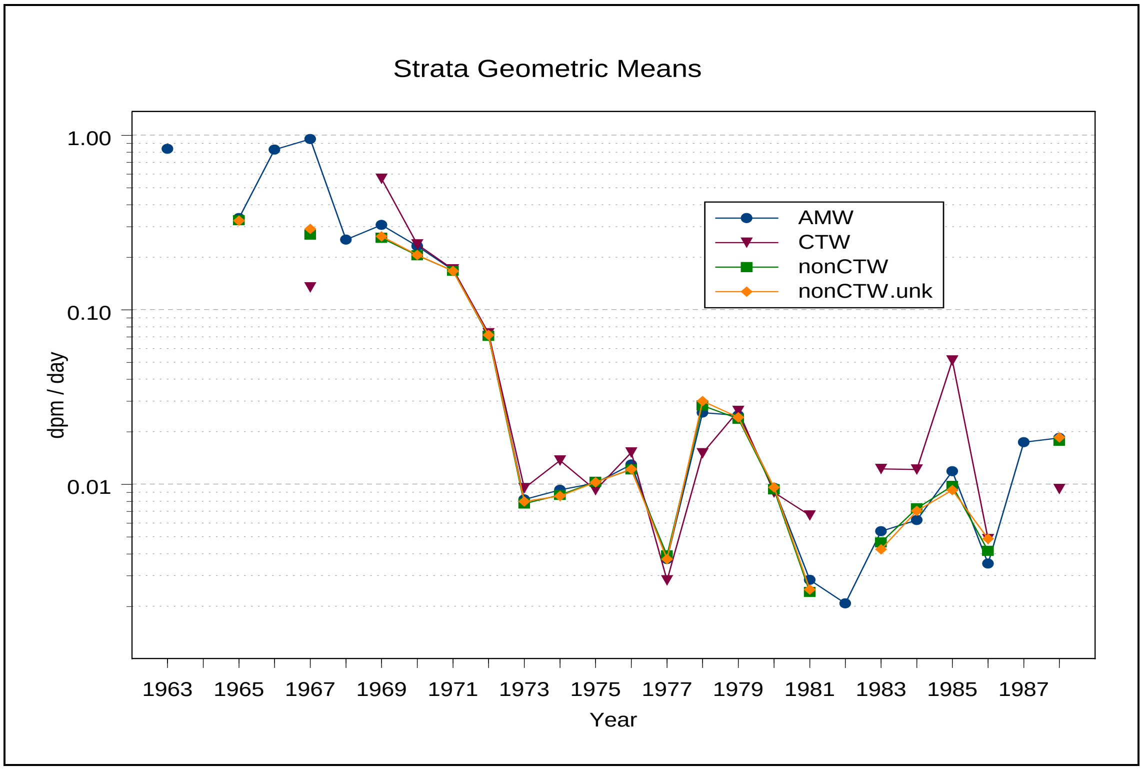

Figure 4-1. Strata GMs.

Intake rate comparisons for each strata were performed for 1973 through 1989. Figures 4-3 to 4-5 depict the excretion curve fit through the 1973 to 1989 urinary excretion data for the CTW, nonCTW, and nonCTW+unk strata, respectively. This period is modeled because it is the intake period containing the time period where a statistically significant difference was found. For the actual coworker study, additional intake periods, before and after this time period will be modeled.

In order to assess practical significance, a *t*-test for equal slopes will determine whether the constant chronic intake rates for the strata are the same. The hypotheses for these tests are

H_0: The slopes of the two regression lines are equal (i.e. the constant chronic intake rates for the two strata are the same).

H_A: The slopes of the two regression lines are not equal (i.e. the constant chronic intake rates for the two strata are different).

Using the intake rates and standard errors from Table 4-2, as determined by IMBA, the test statistic and p-value for the CTW vs. nonCTW comparison are

$$t_{CTW:nonCTW} = \frac{b_{CTW} - b_{nonCTW}}{\sqrt{s_{CTW}^2 + s_{nonCTW}^2}} = \frac{0.9861 - 0.716}{\sqrt{0.2222^2 + 0.1522^2}} = 1.0029$$

$$p - value_{CTW:nonCTW} = 2 \times P\left(t_{df=26} > 1.0029\right) = 0.3252$$

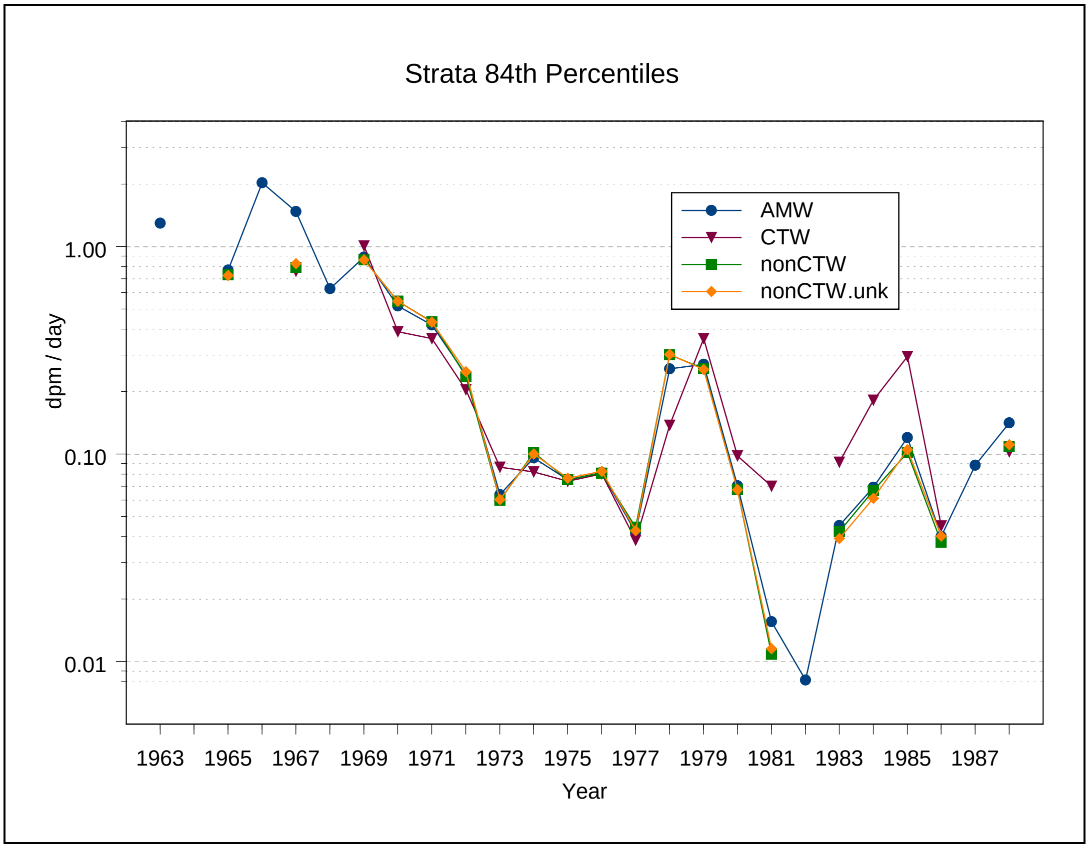

Figure 4-2. Strata 84th percentiles.

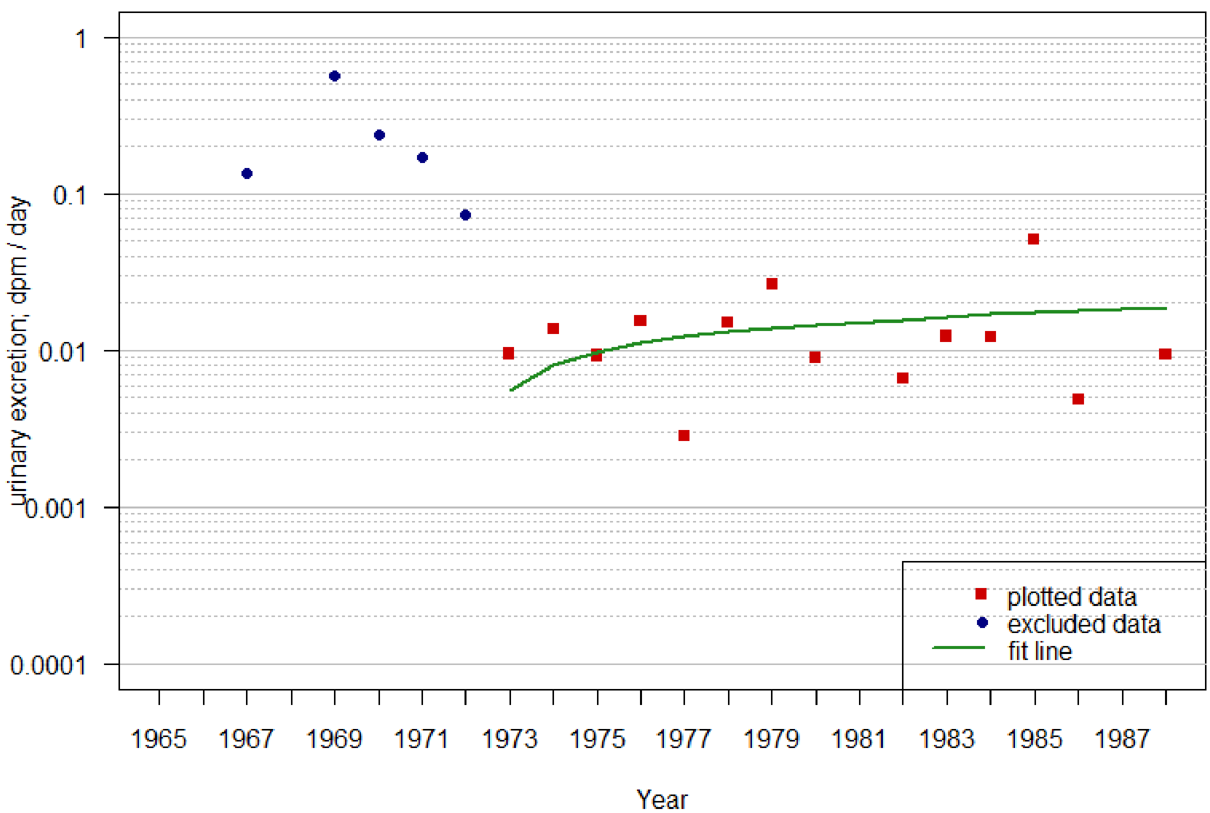

Figure 4-3. Intake modeling for CTW, 1973 to 1989, 50th percentile.

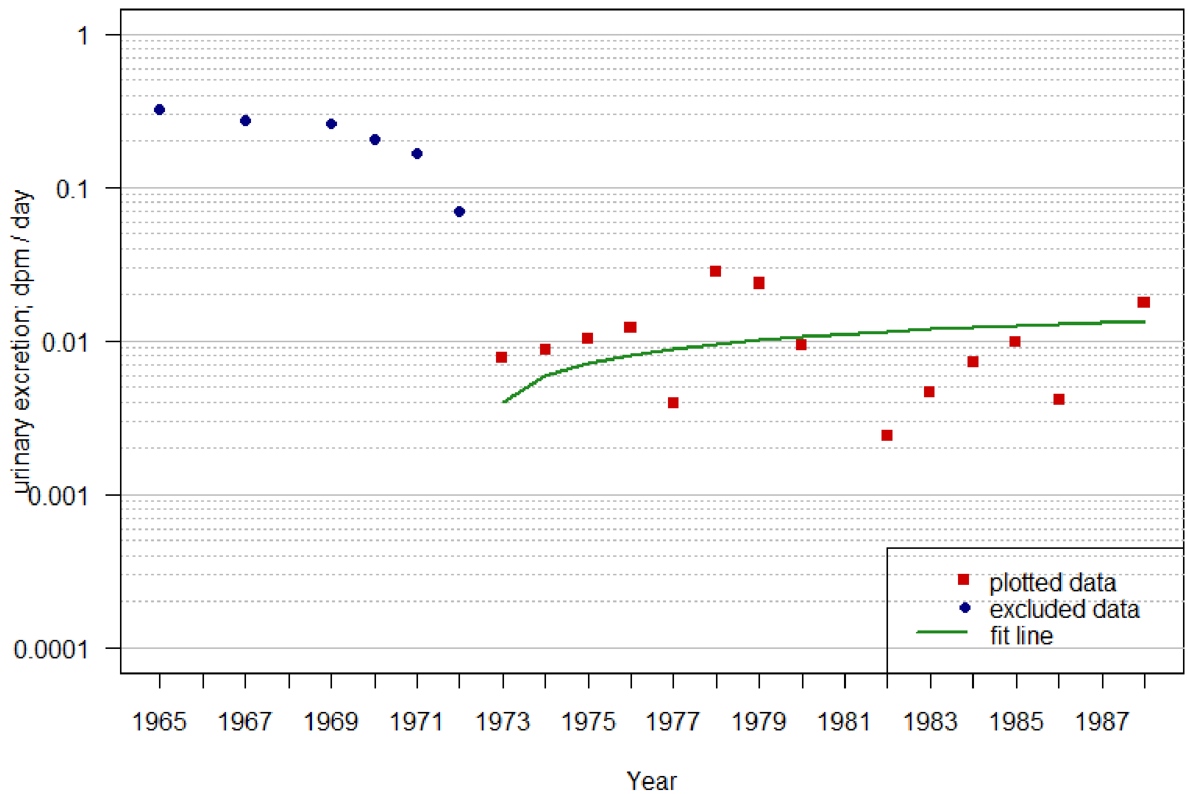

Figure 4-4. Intake modeling for nonCTW, 1973 to 1989, 50th percentile.

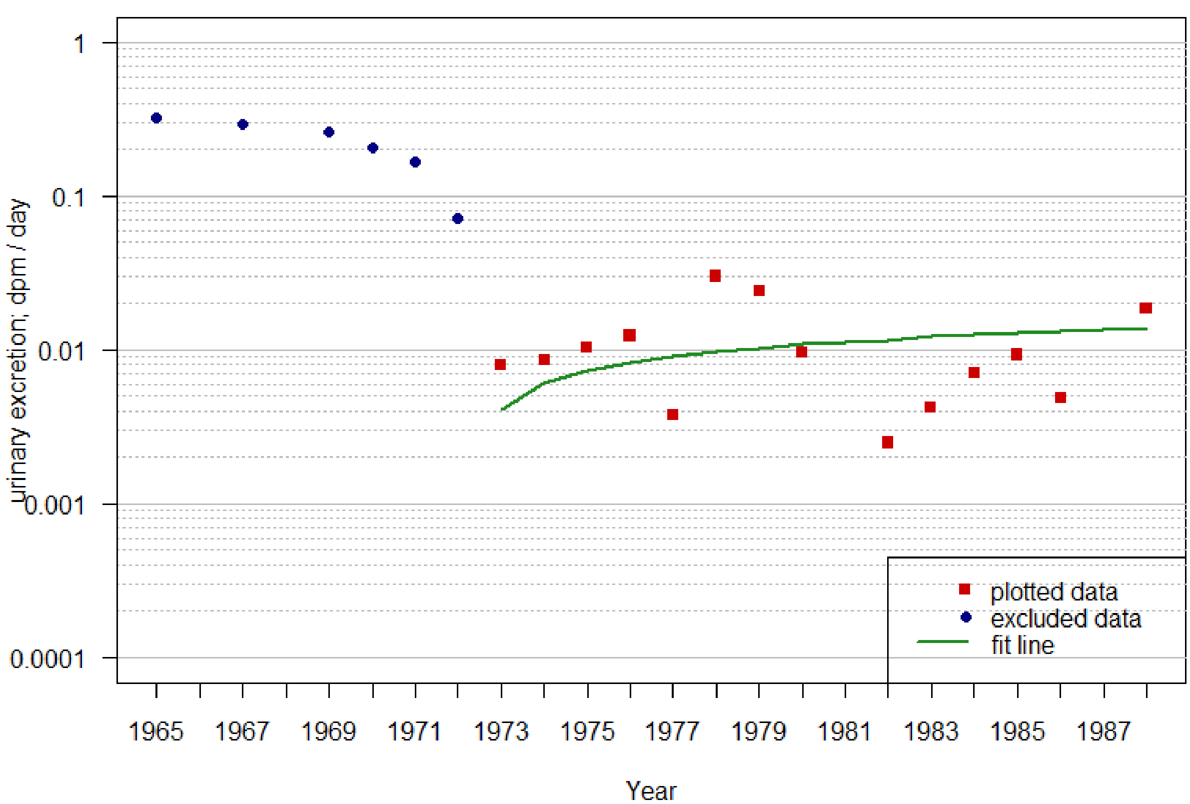

Figure 4-5. Intake modeling for nonCTW+unk, 1973 to 1989, 50th percentile.

Likewise, the test statistic and p-value for the CTW vs. nonCTW+unk comparison are

$$t_{CTW:nonCTW+unk} = \frac{b_{CTW} - b_{nonCTW+unk}}{\sqrt{s^2_{CTW} + s^2_{nonCTW+unk}}} = \frac{0.9861 - 0.7306}{\sqrt{0.2222^2 + 0.1597^2}} = 0.9337$$

$$p-value_{CTW:nonCTW+unk} = 2 \times P\left(t_{df=26} > 0.9337\right) = 0.3590$$

These test statistics and p-values, used to compare the nonCTW and nonCTW+unk strata to the CTW strata, are also provided in Table 4-2.

Table 4-2. Strata intake rates, 1973 to 1989.

Stratum	50th-percentile intake rate (dpm/day)	Variance	Test statistic	p-value
CTW	0.9861	0.2222	N/A	N/A
nonCTW	0.716	0.1522	1.0029	0.3252
nonCTW+unk	0.7306	0.1597	0.9337	0.3590

Both of the p-values for the strata comparisons are greater than 0.05. Therefore, there is not enough evidence that there may be a difference between the slopes of the two regression lines (and as a consequence, there is not enough evidence that the chronic intakes between the two strata are different). This leads to the conclusion that, for the purpose of intake modeling, there is no statistical or practical difference between the strata. A graphical depiction of the similarity can be seen in Figure 4-6, where the various fit lines are close together and well within the bounds of the data and the uncertainty of the AMW fit.

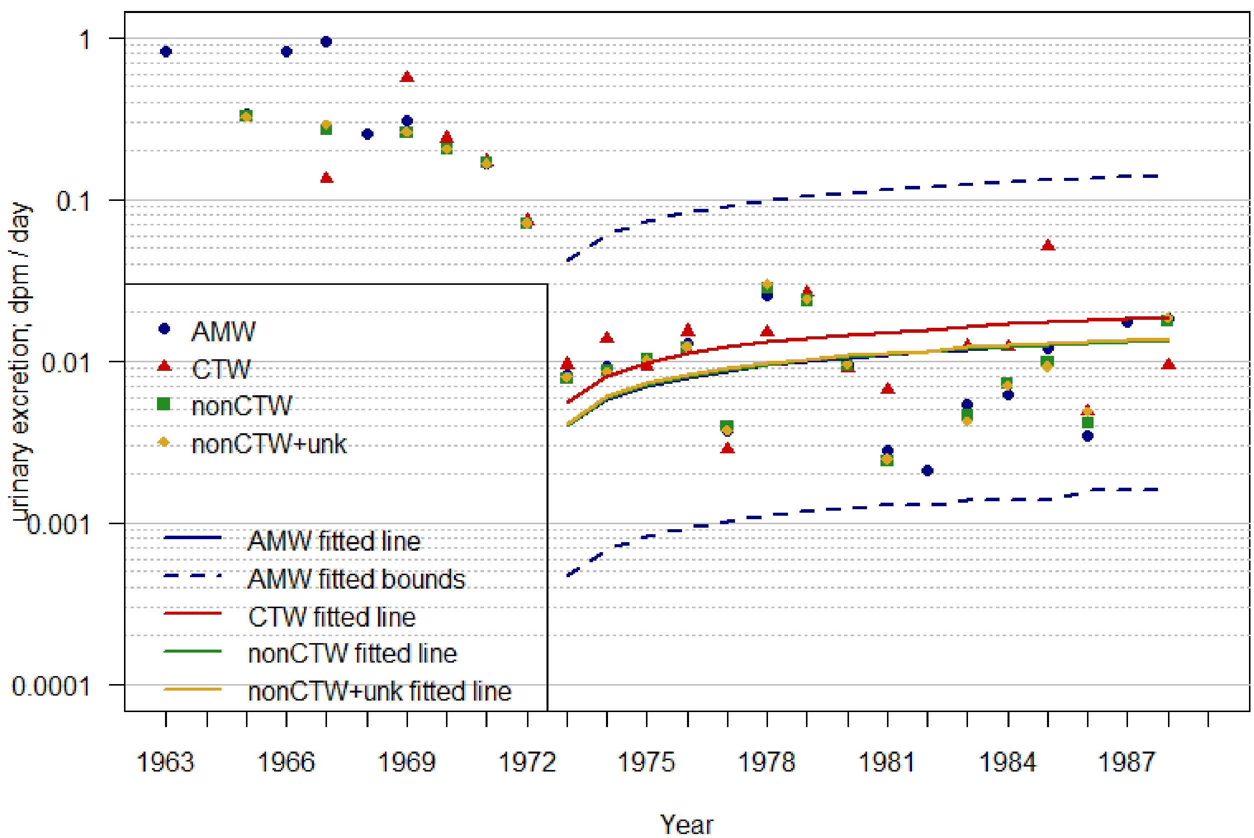

Figure 4-6. 1973 to 1989 fit lines for AMW, CTW, nonCTW, and nonCTW+unk.

5.0 CONCLUSIONS

Statistical analysis revealed that the CTW stratum differs from the nonCTW and nonCTW+unk strata in a statistically significant manner in only 1985. From a practical standpoint, these urinary excretion data are inputs to intake modeling, which is used to determine actual intake rates that would result in these excretion rates. The intake modeling fits the data as a series of multiyear chronic intakes. For all the strata, the data from 1973 to 1989 can be considered as one intake period because all the excretion rates tend to vary about 0.01 dpm/day for that entire period. This intake period includes 1985, the one period with a statistically significant difference. Over this period, there is no practical difference between the CTW and the other strata. Therefore, there would be no benefit in evaluating the CTW stratum separately from other site workers and the SRS internal dose coworker study should evaluate exotic trivalent radionuclides intakes based on the AMW data.

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ATTACHMENT A
ROS AND EFFECTIVE FIT PLOTS FOR AMWS, CTW, NONCTWS, AND NONCTW+UNKS

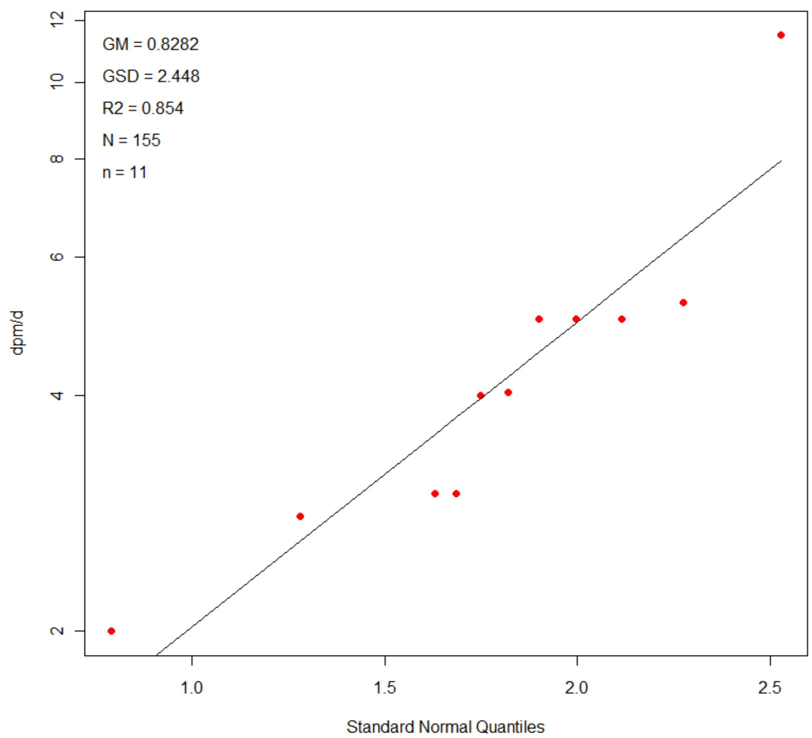

Figure A-1. ROS fit for AMWs, 1966.

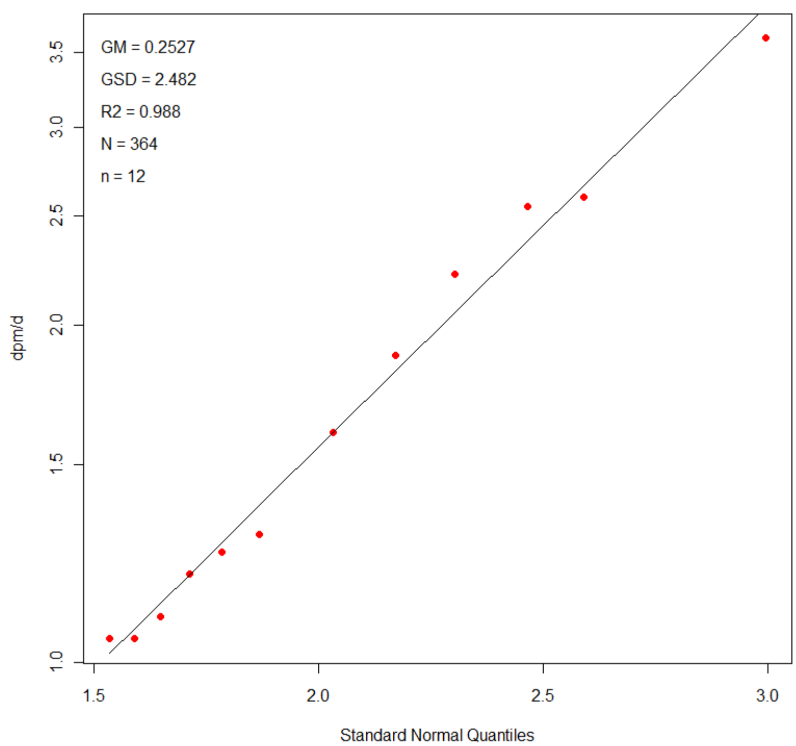

Figure A-2. ROS fit for AMWs, 1968.

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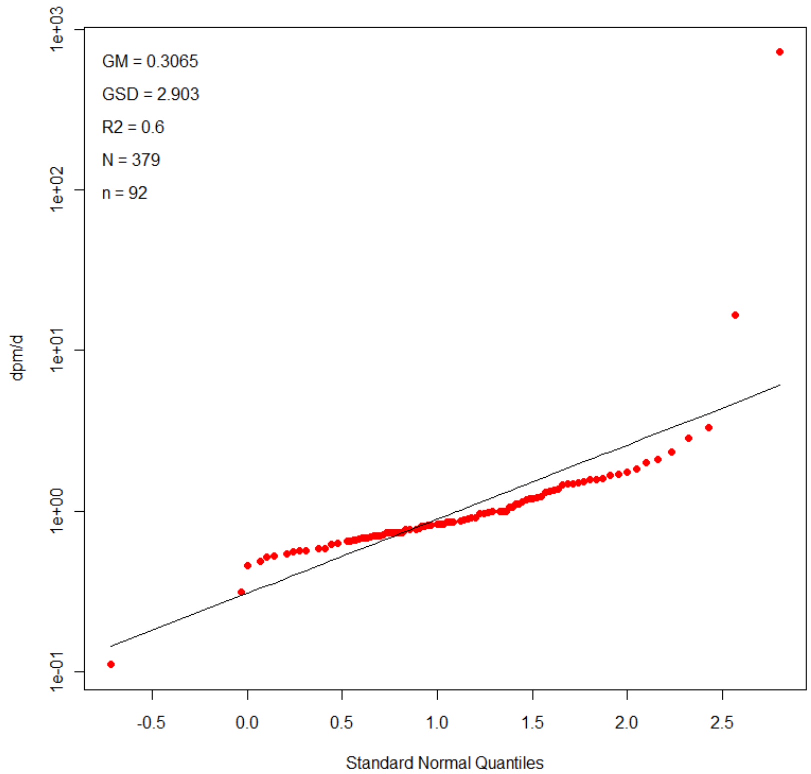

Figure A-3. ROS fit for AMWs, 1969.

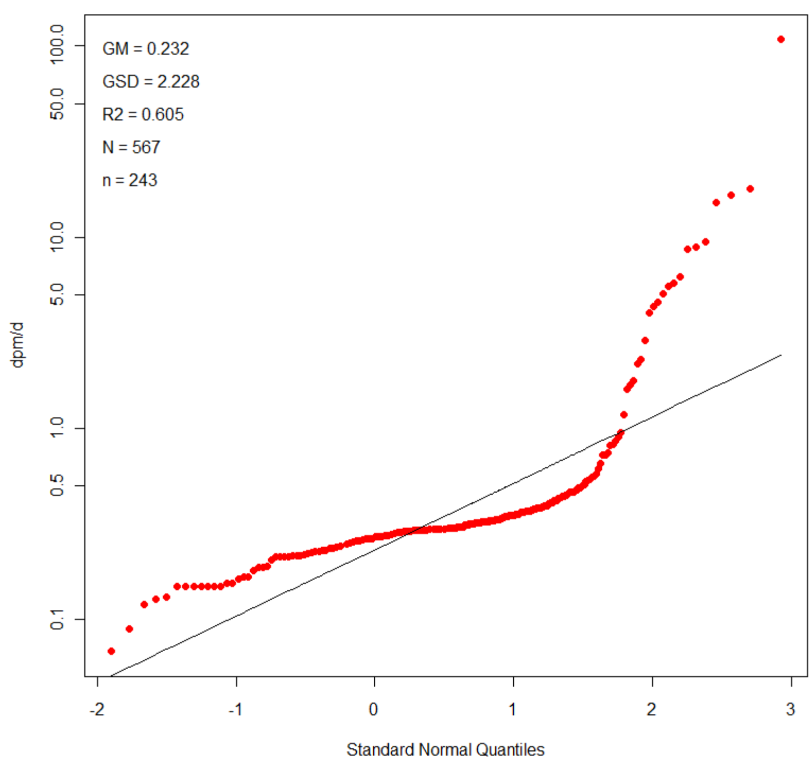

Figure A-4. ROS fit for AMWs, 1970.

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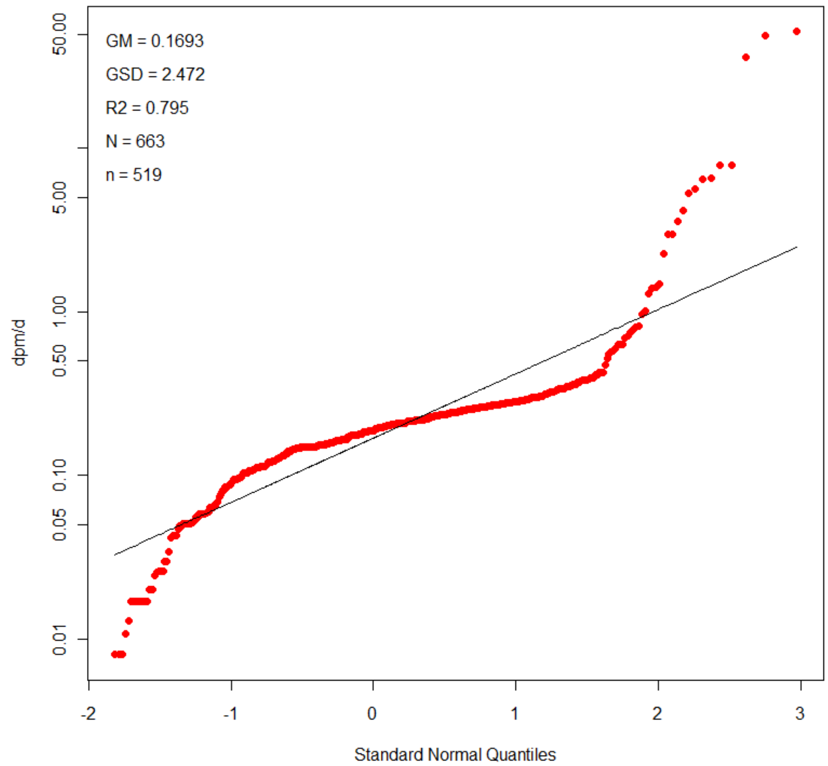

Figure A-5. ROS fit for AMWs, 1971.

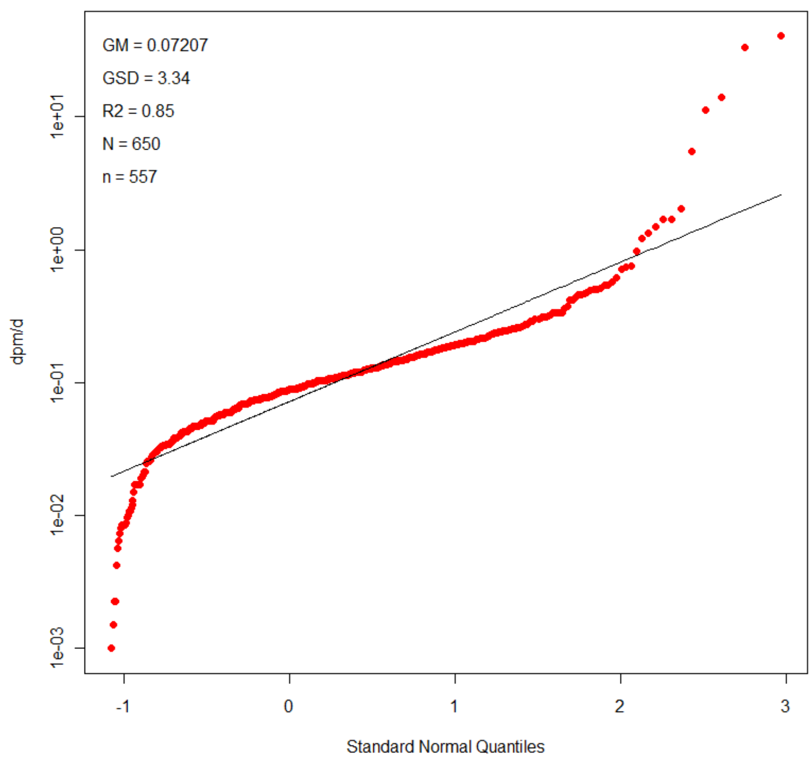

Figure A-6. ROS fit for AMWs, 1972.

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ROS AND EFFECTIVE FIT PLOTS FOR AMWS, CTW, NONCTWS, AND NONCTW+UNKS

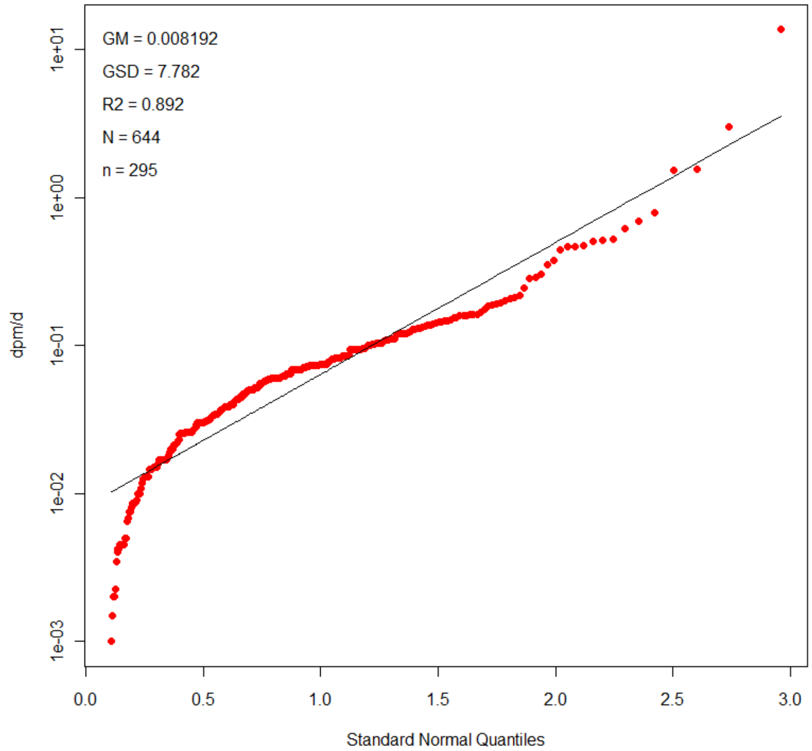

Figure A-7. ROS fit for AMWs, 1973.

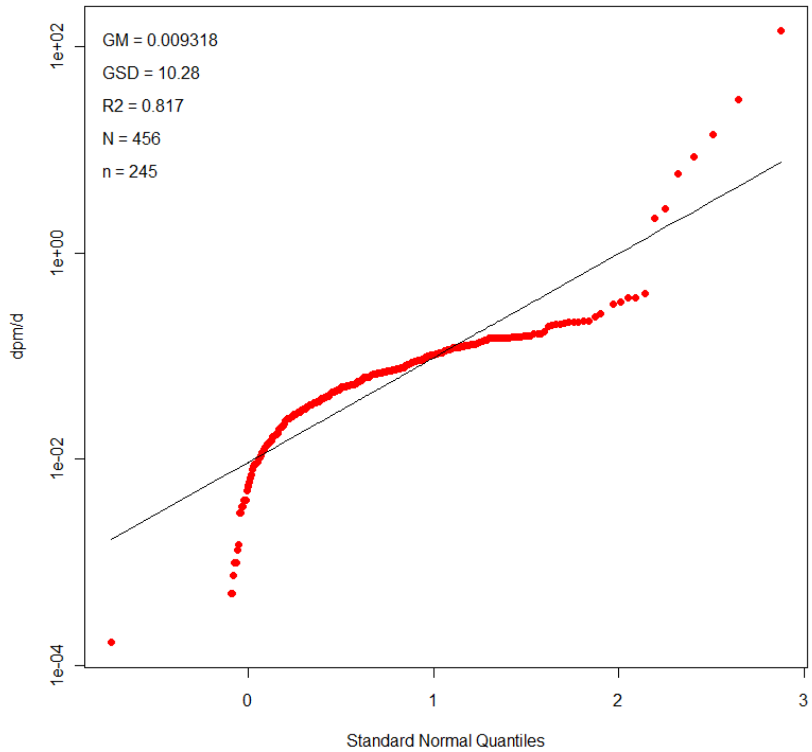

Figure A-8. ROS fit for AMWs, 1974.

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ROS AND EFFECTIVE FIT PLOTS FOR AMWS, CTW, NONCTWS, AND NONCTW+UNKS

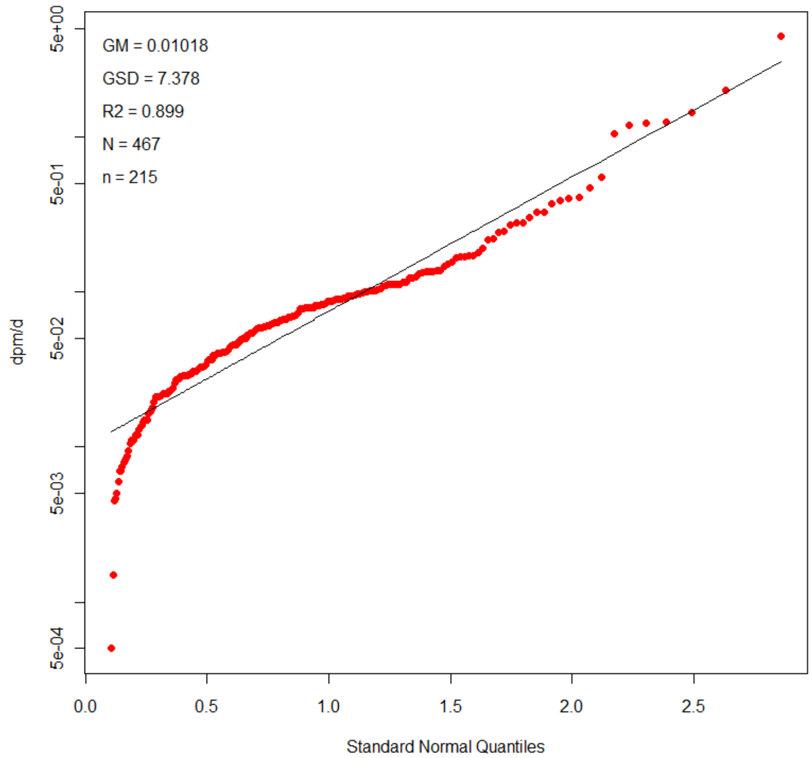

Figure A-9. ROS fit for AMWs, 1975.

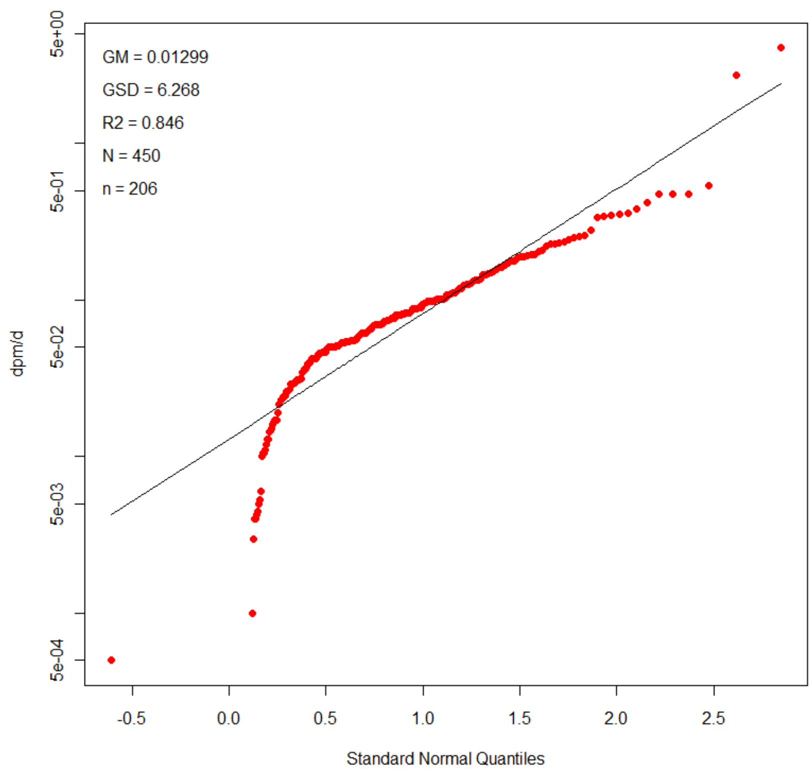

Figure A-10. ROS fit for AMWs, 1976.

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ROS AND EFFECTIVE FIT PLOTS FOR AMWS, CTW, NONCTWS, AND NONCTW+UNKS

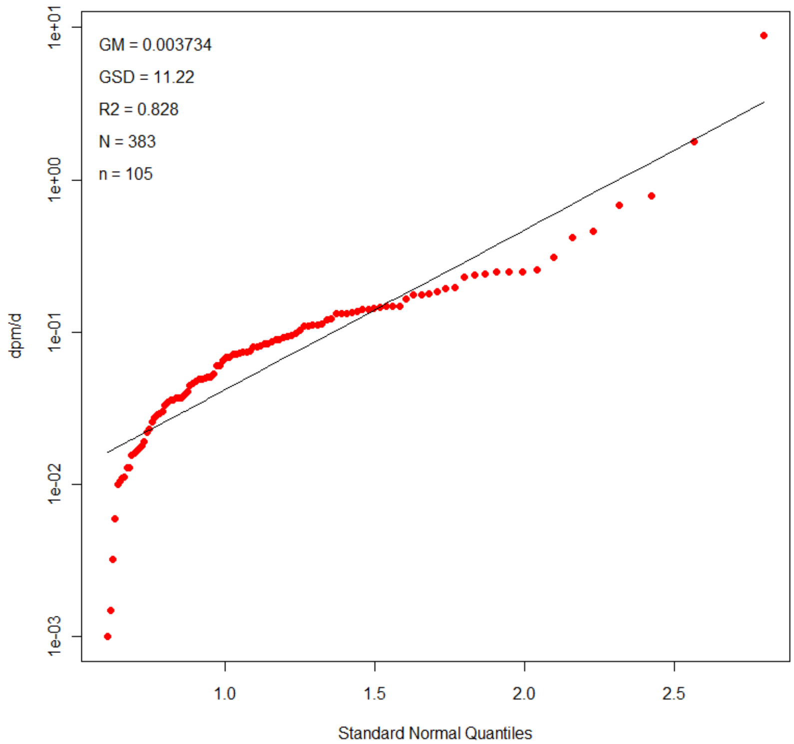

Figure A-11. ROS fit for AMWs, 1977.

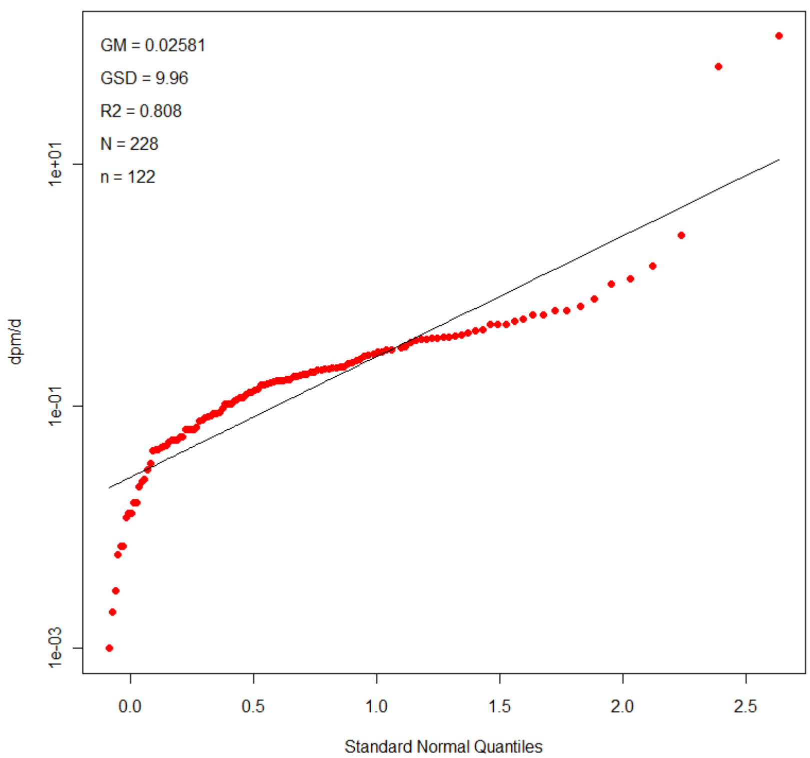

Figure A-12. ROS fit for AMWs, 1978.

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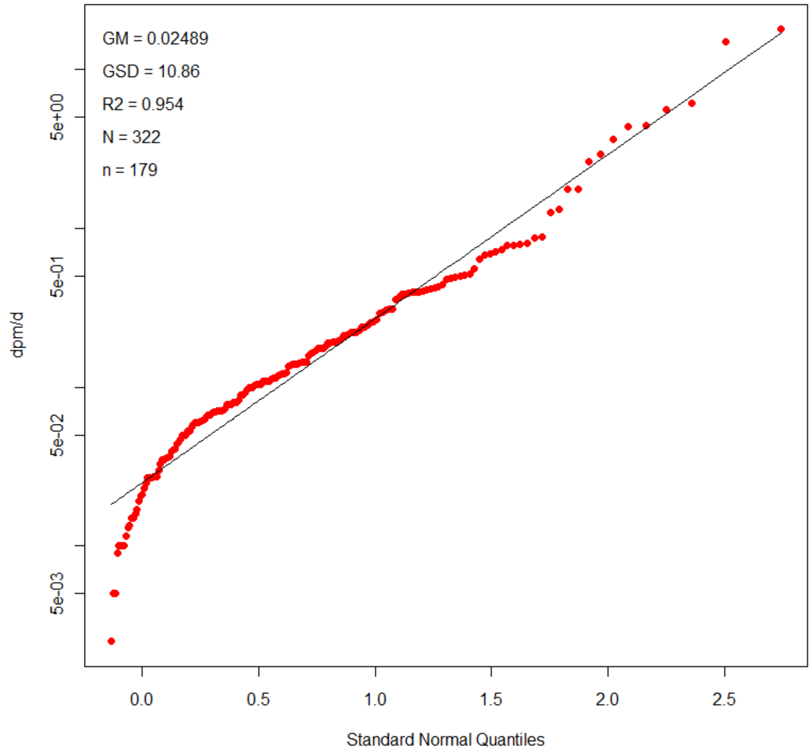

Figure A-13. ROS fit for AMWs, 1979.

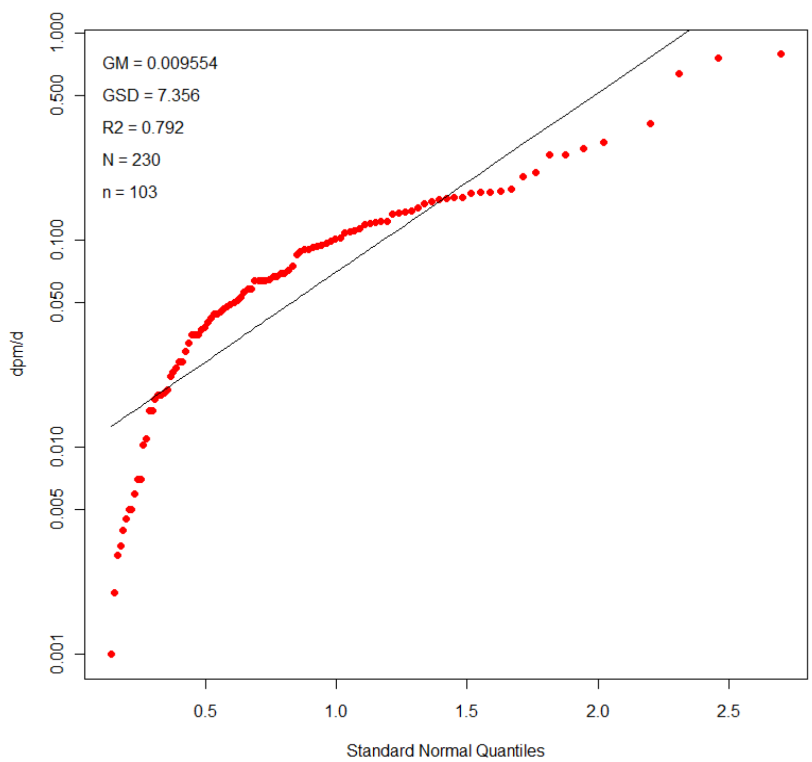

Figure A-14. ROS fit for AMWs, 1980.

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ROS AND EFFECTIVE FIT PLOTS FOR AMWS, CTW, NONCTWS, AND NONCTW+UNKS
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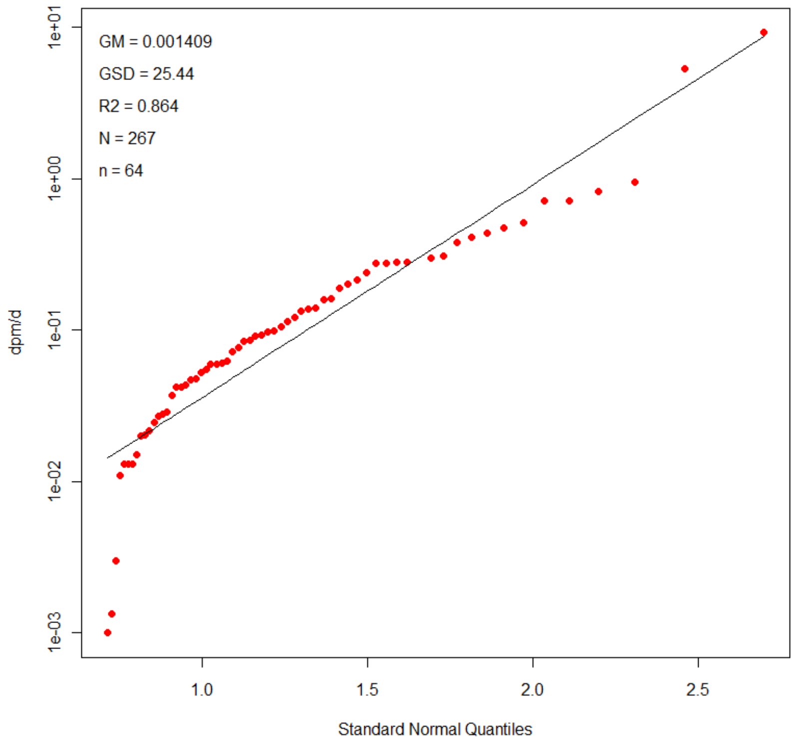

Figure A-15. ROS fit for AMWs, 1981.

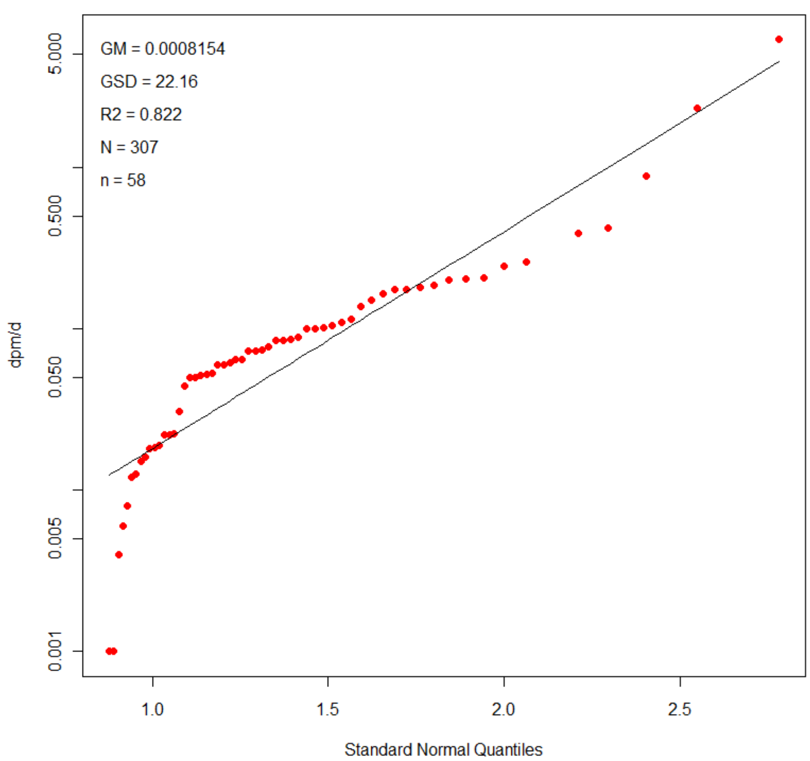

Figure A-16. ROS fit for AMWs, 1982.

ATTACHMENT A
ROS AND EFFECTIVE FIT PLOTS FOR AMWS, CTW, NONCTWS, AND NONCTW+UNKS

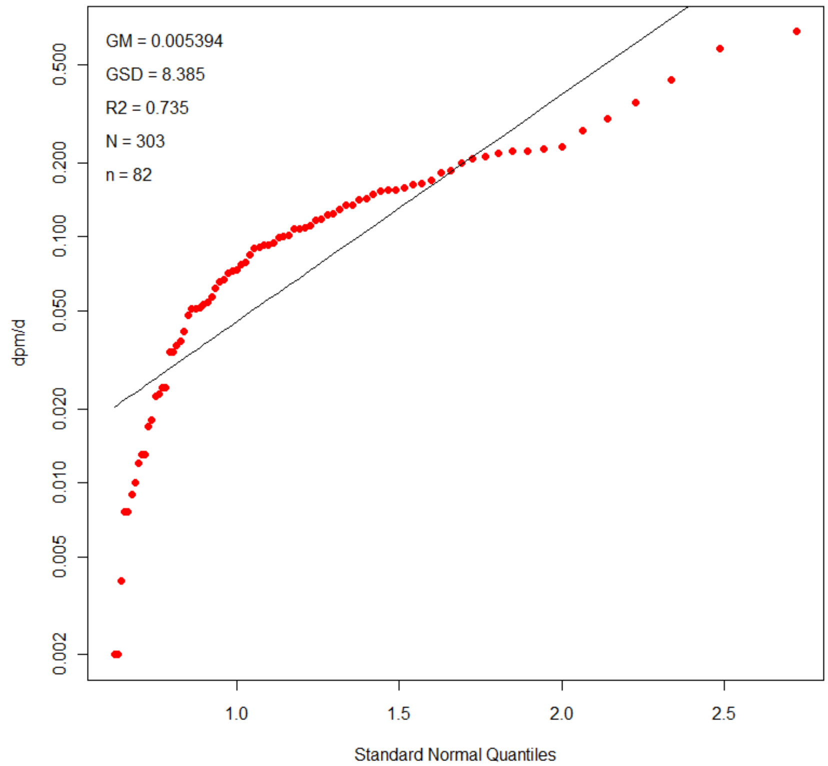

Figure A-17. ROS fit for AMWs, 1983.

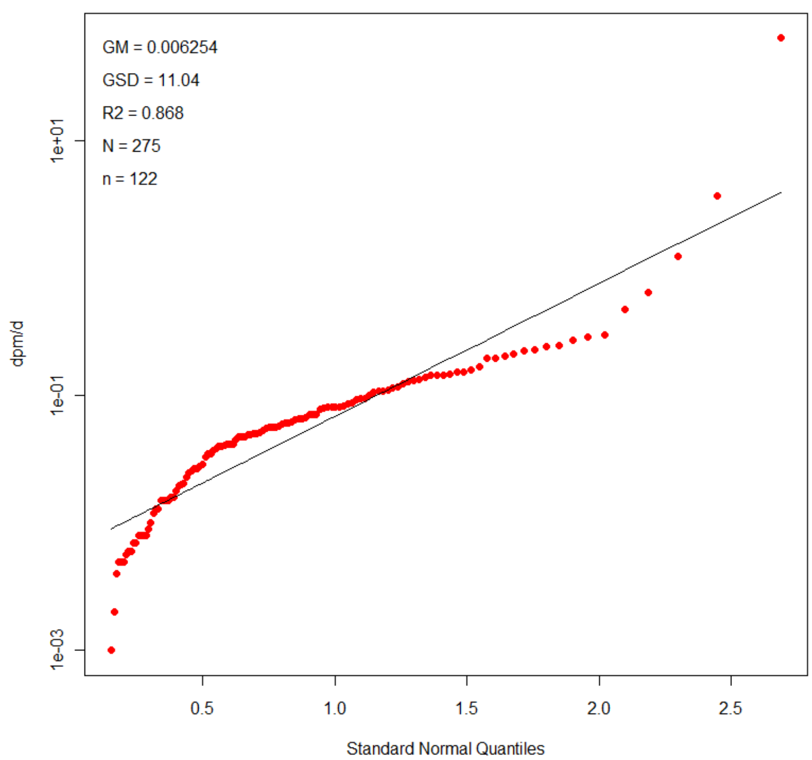

Figure A-18. ROS fit for AMWs, 1984.

ATTACHMENT A
ROS AND EFFECTIVE FIT PLOTS FOR AMWS, CTW, NONCTWS, AND NONCTW+UNKS

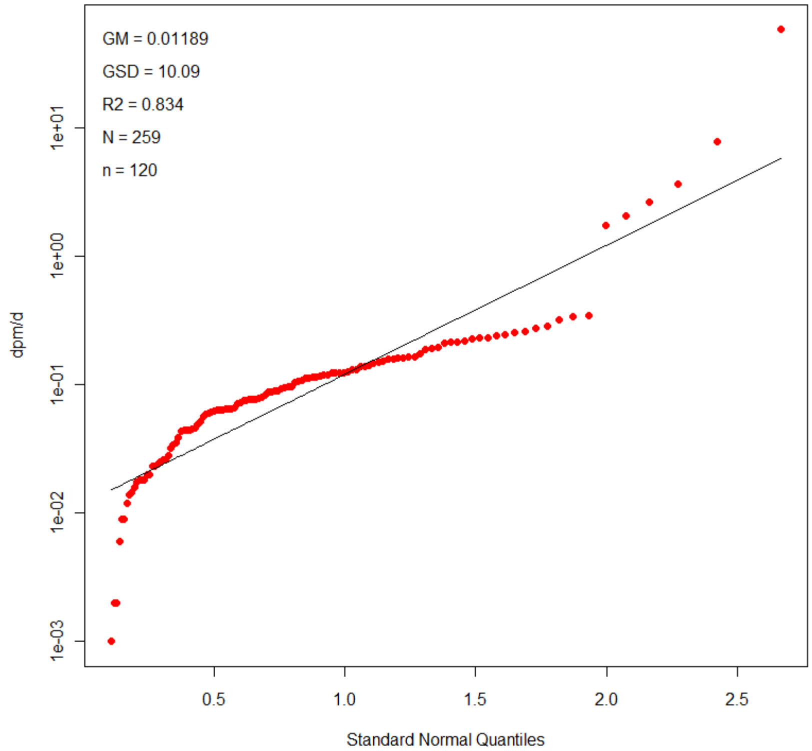

Figure A-19. ROS fit for AMWs, 1985.

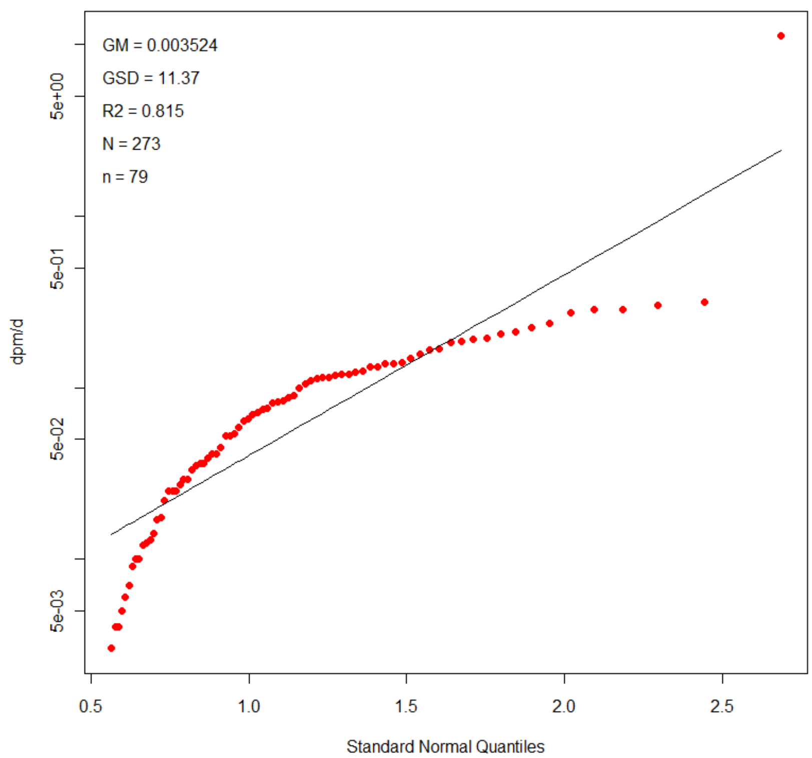

Figure A-20. ROS fit for AMWs, 1986.

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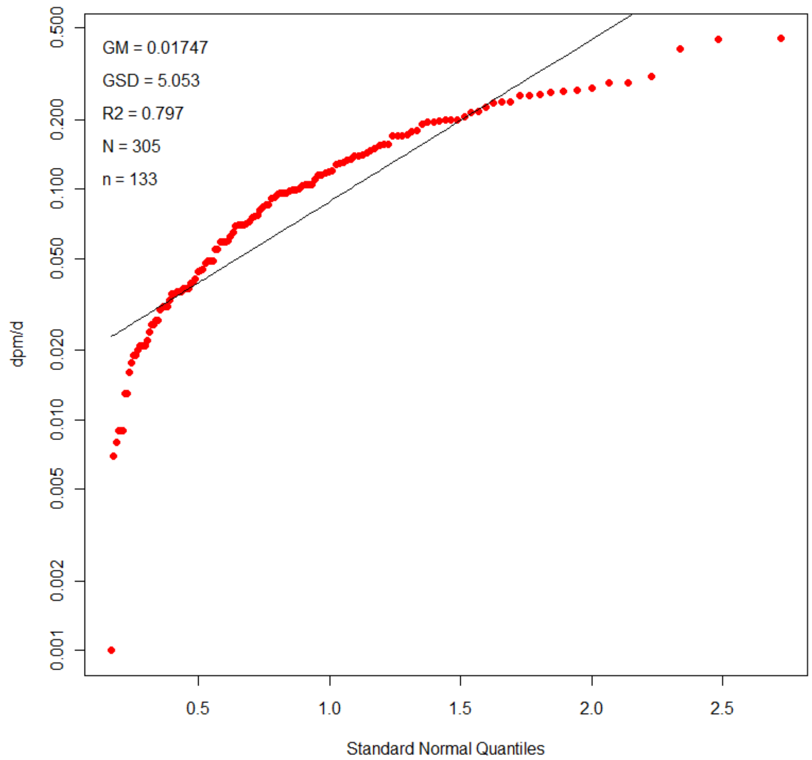

Figure A-21. ROS fit for AMWs, 1987.

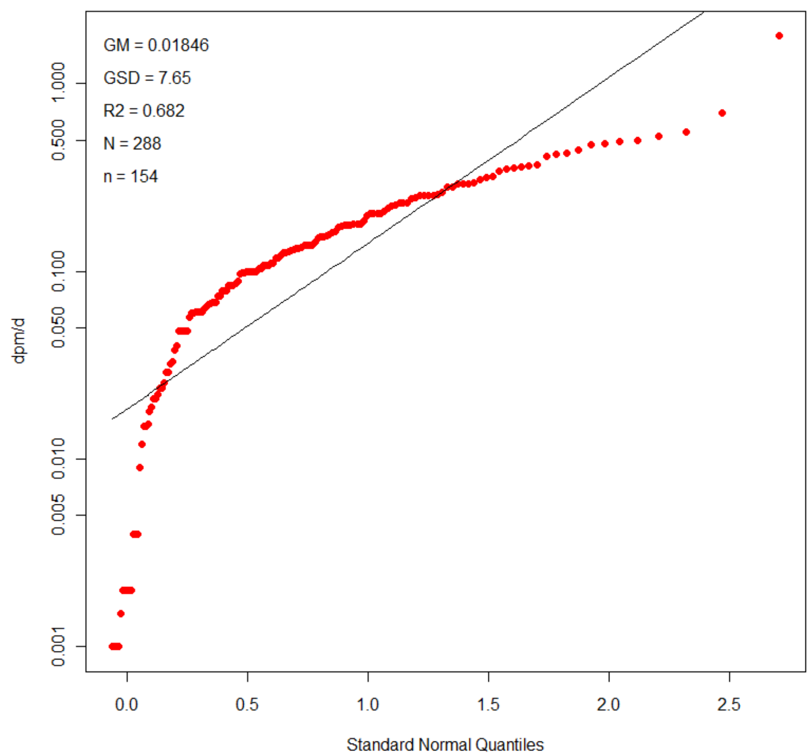

Figure A-22. ROS fit for AMWs, 1988 to 1989.

ATTACHMENT A
ROS AND EFFECTIVE FIT PLOTS FOR AMWS, CTW, NONCTWS, AND NONCTW+UNKS

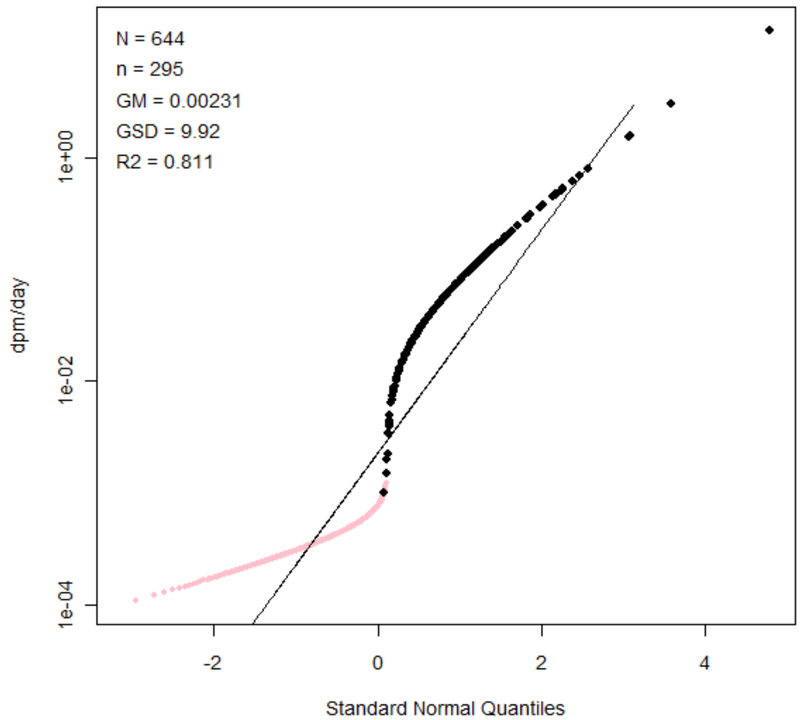

Figure A-23. Effective fit for AMWs, 1973.

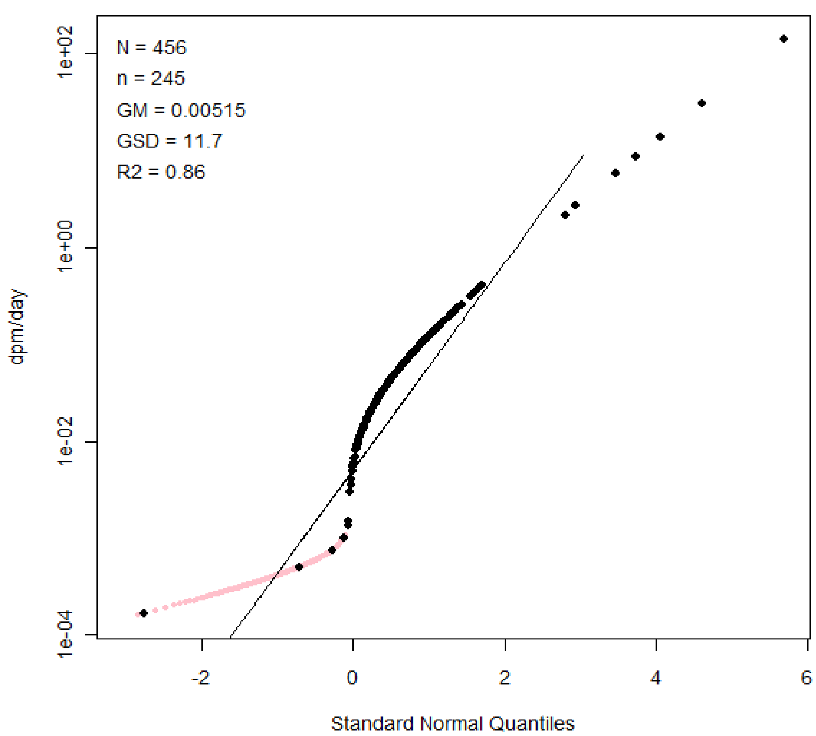

Figure A-24. Effective fit for AMWs, 1974.

ATTACHMENT A
ROS AND EFFECTIVE FIT PLOTS FOR AMWS, CTW, NONCTWS, AND NONCTW+UNKS

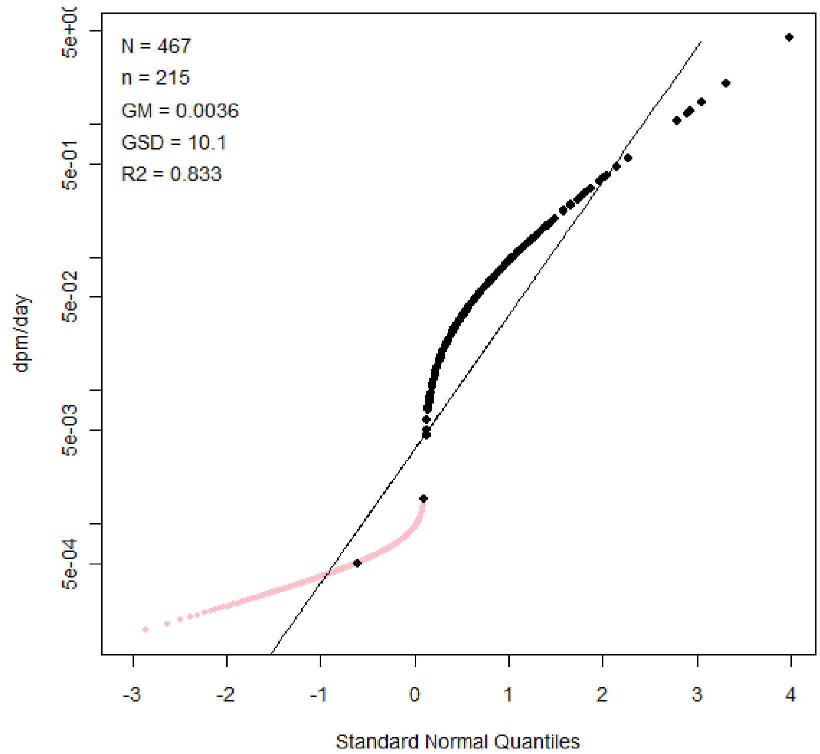

Figure A-25. Effective fit for AMWs, 1975.

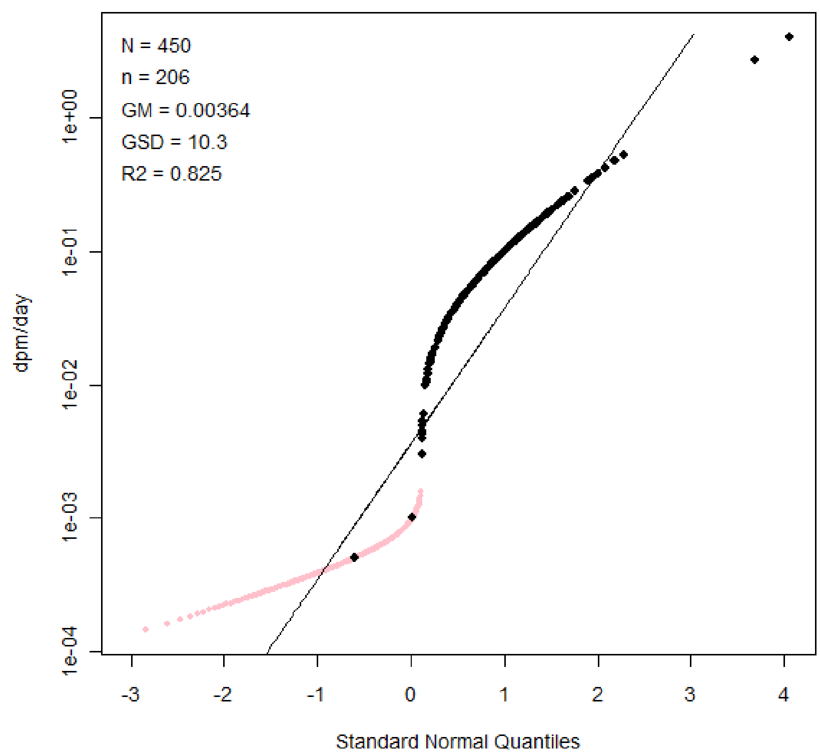

Figure A-26. Effective fit for AMWs, 1976.

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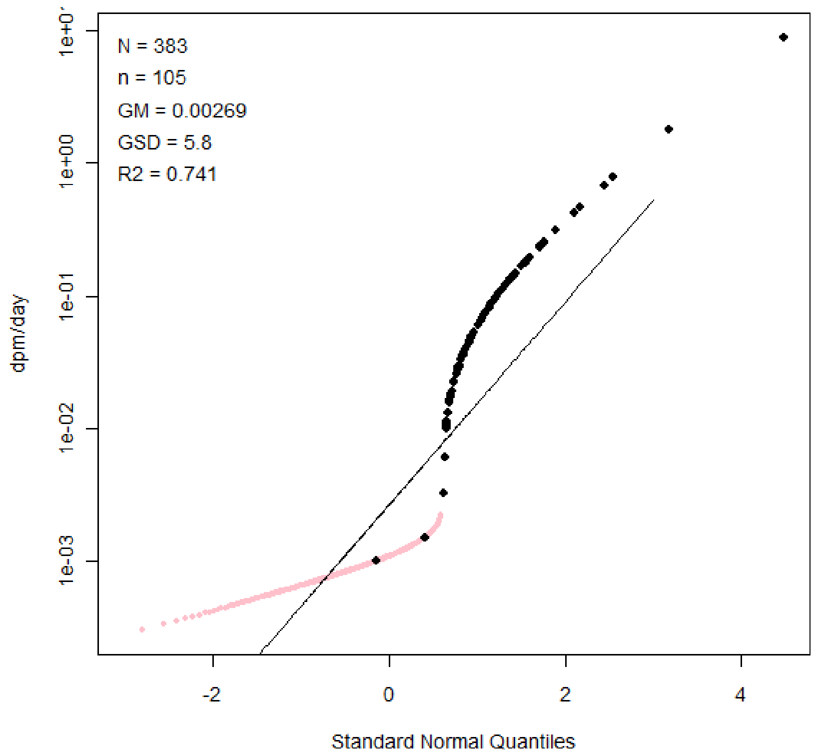

Figure A-27. Effective fit for AMWs, 1977.

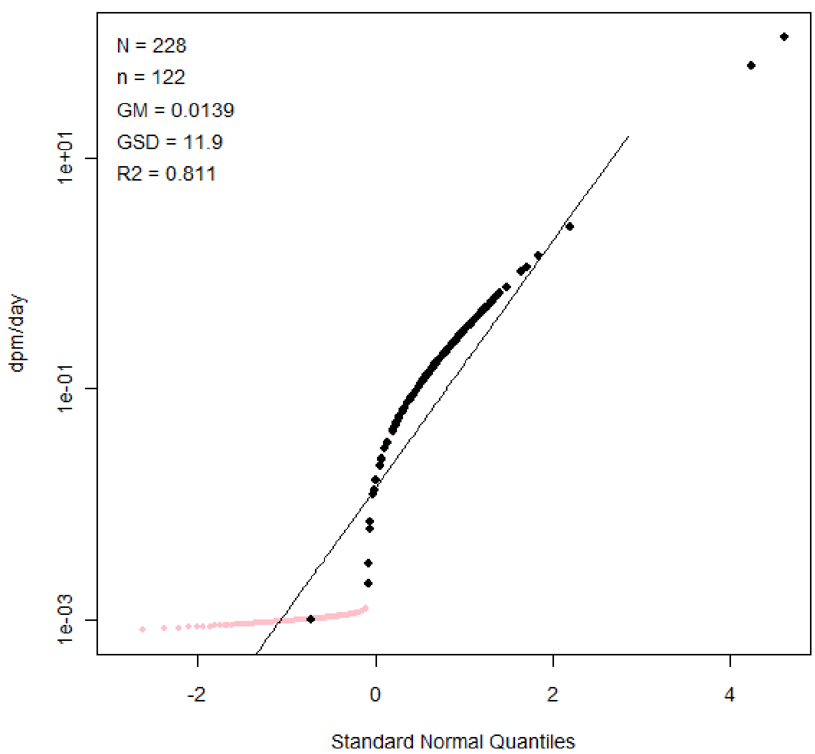

Figure A-28. Effective fit for AMWs, 1978.

ATTACHMENT A
ROS AND EFFECTIVE FIT PLOTS FOR AMWS, CTW, NONCTWS, AND NONCTW+UNKS

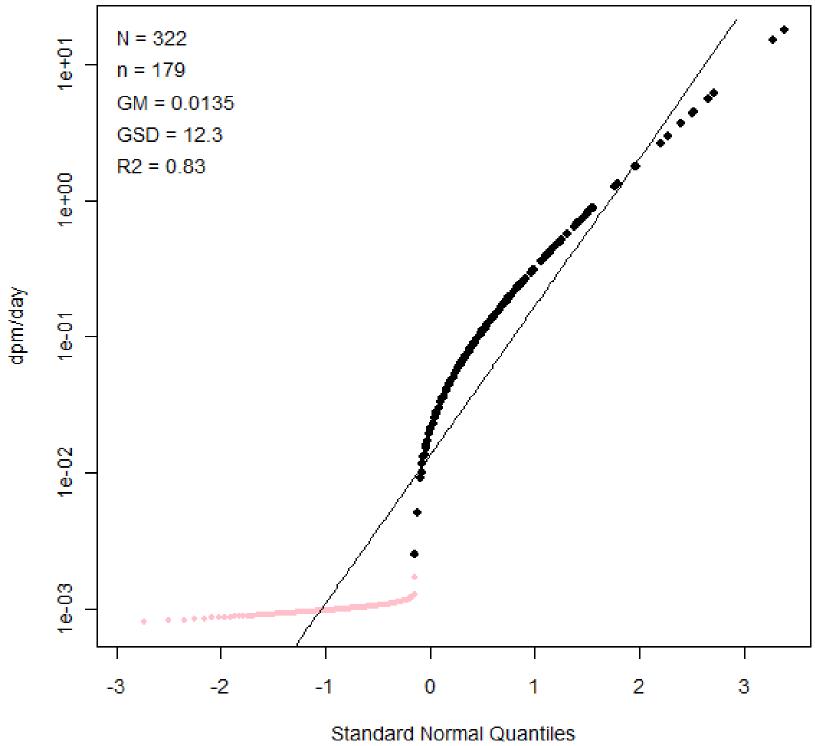

Figure A-29. Effective fit for AMWs, 1979.

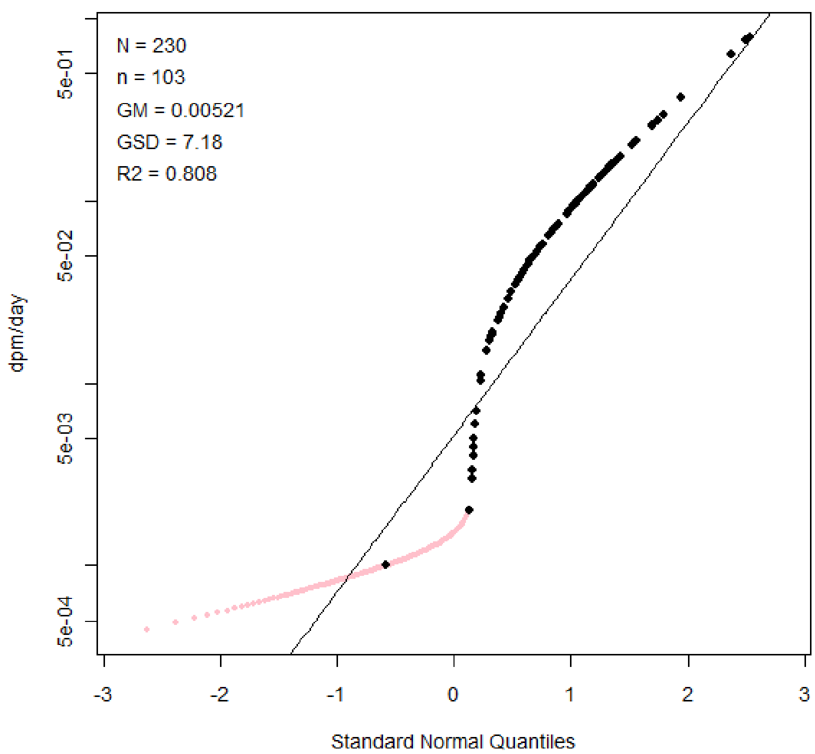

Figure A-30. Effective fit for AMWs, 1980.

ATTACHMENT A
ROS AND EFFECTIVE FIT PLOTS FOR AMWS, CTW, NONCTWS, AND NONCTW+UNKS

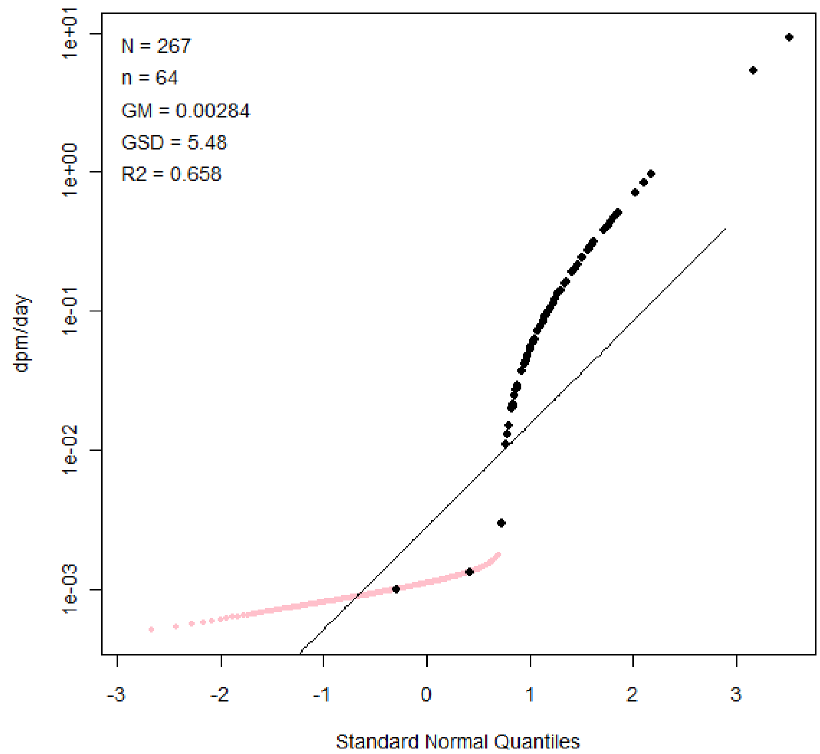

Figure A-31. Effective fit for AMWs, 1981.

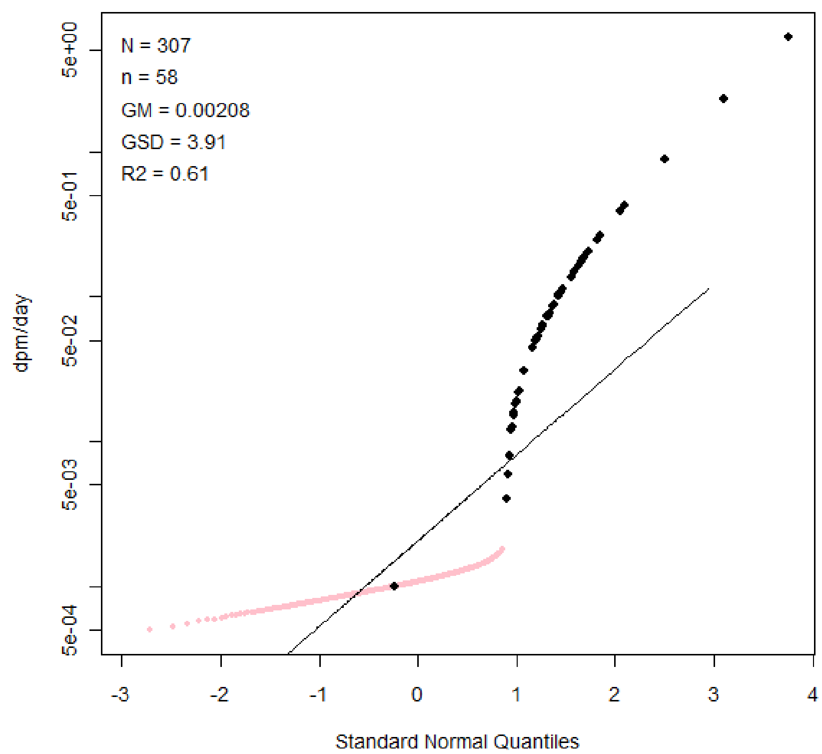

Figure A-32. Effective fit for AMWs, 1982.

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ROS AND EFFECTIVE FIT PLOTS FOR AMWS, CTW, NONCTWS, AND NONCTW+UNKS

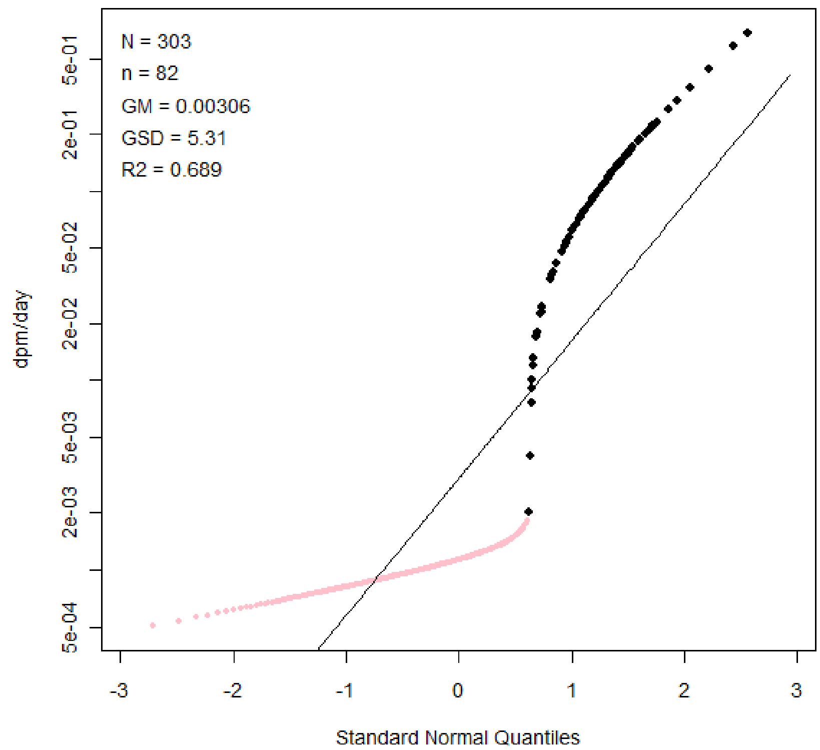

Figure A-33. Effective fit for AMWs, 1983.

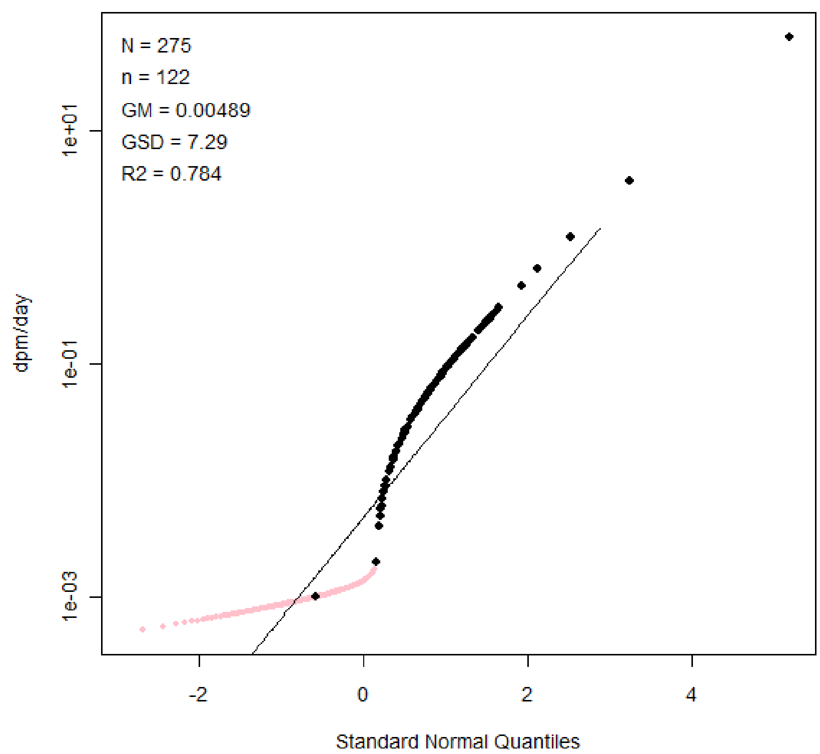

Figure A-34. Effective fit for AMWs, 1984.

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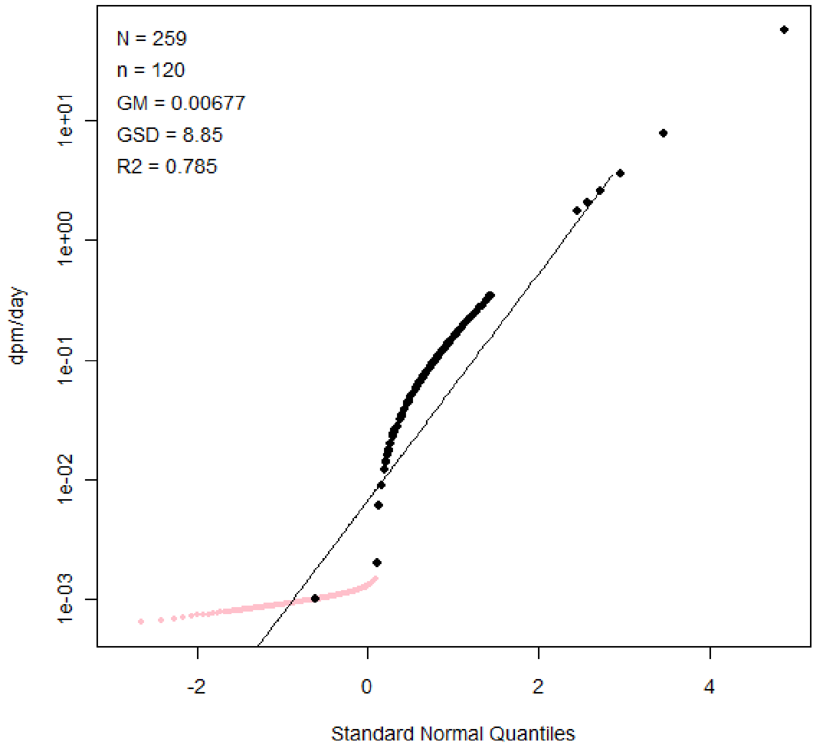

Figure A-35. Effective fit for AMWs, 1985.

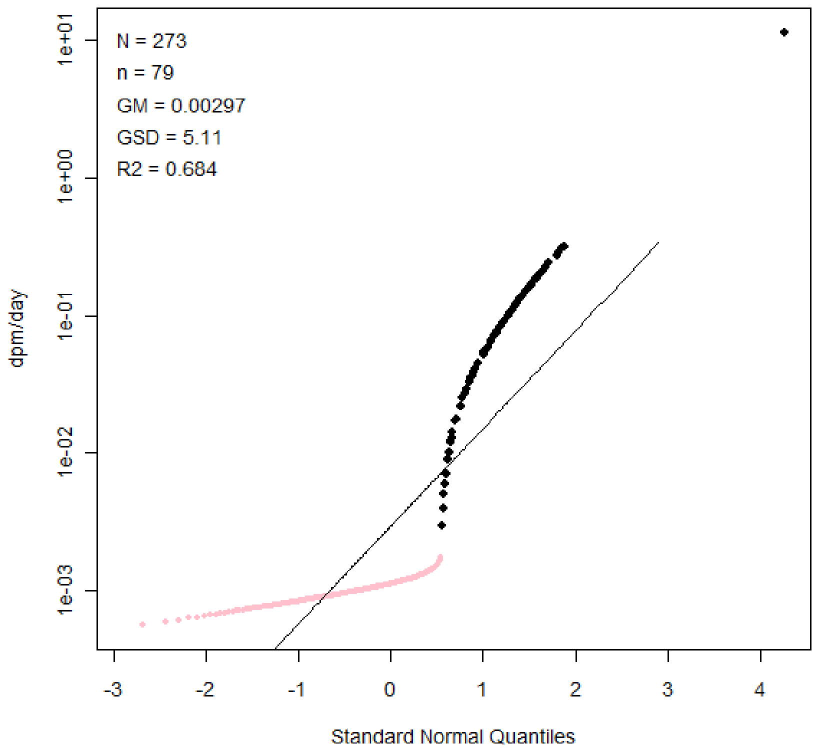

Figure A-36. Effective fit for AMWs, 1986.

ATTACHMENT A
ROS AND EFFECTIVE FIT PLOTS FOR AMWS, CTW, NONCTWS, AND NONCTW+UNKS

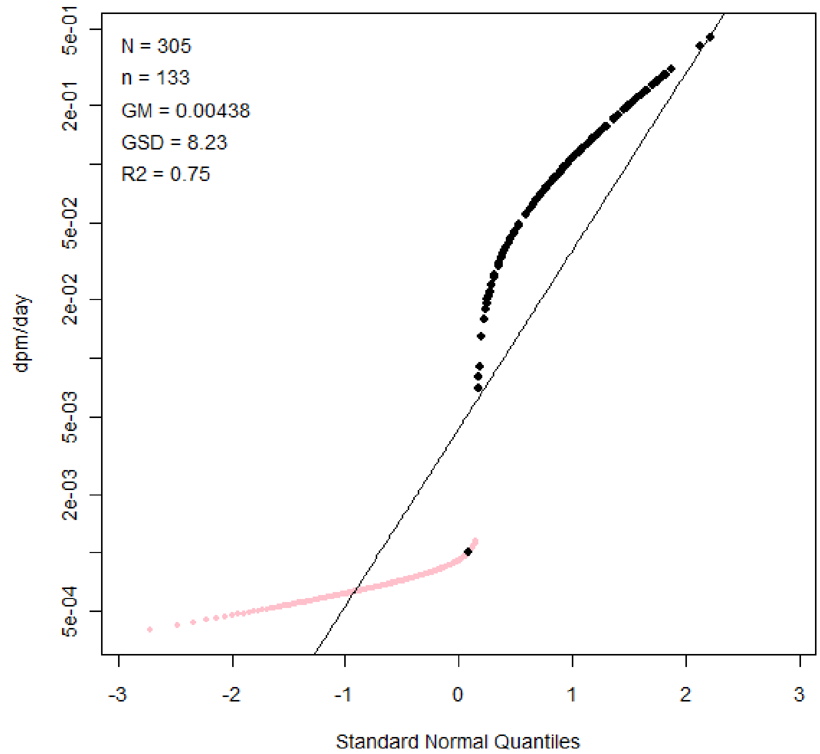

Figure A-37. Effective fit for AMWs, 1987.

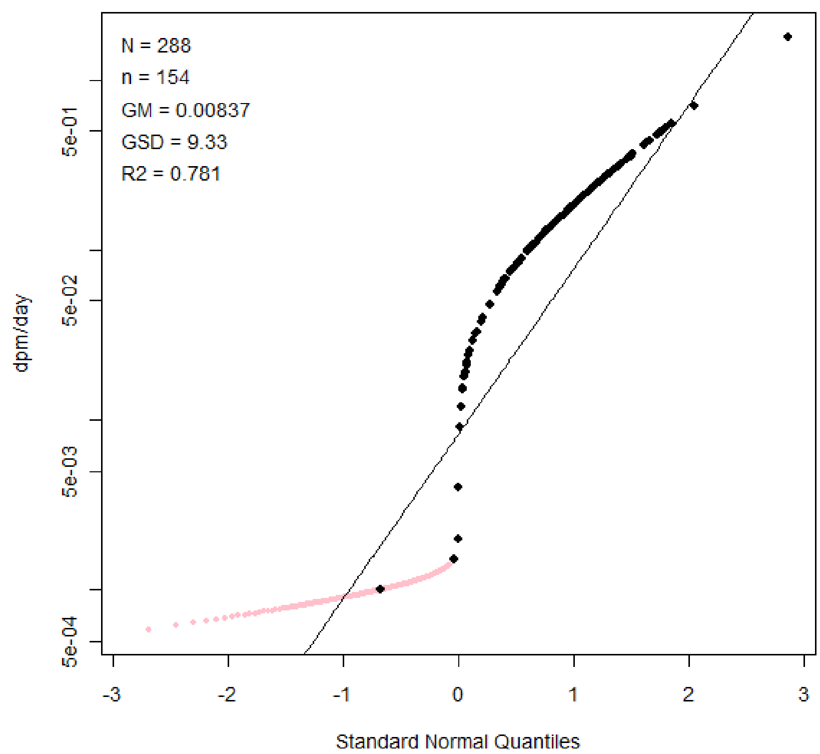

Figure A-38. Effective fit for AMWs, 1988 to 1989.

ATTACHMENT A
ROS AND EFFECTIVE FIT PLOTS FOR AMWS, CTW, NONCTWS, AND NONCTW+UNKS

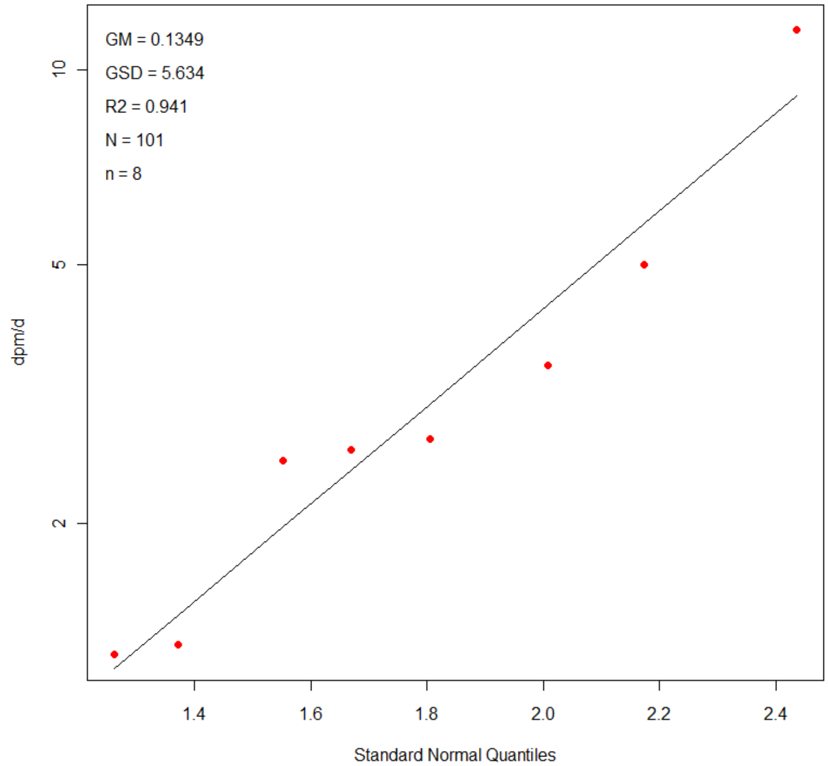

Figure A-39. ROS fit for CTWs, 1966 to 1968.

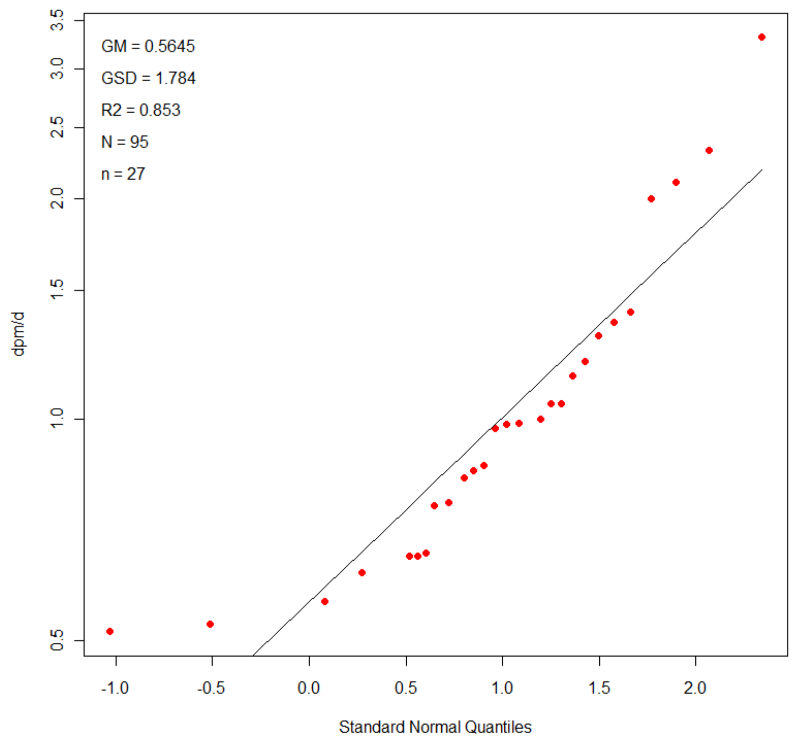

Figure A-40. ROS fit for CTWs, 1969.

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ROS AND EFFECTIVE FIT PLOTS FOR AMWS, CTW, NONCTWS, AND NONCTW+UNKS

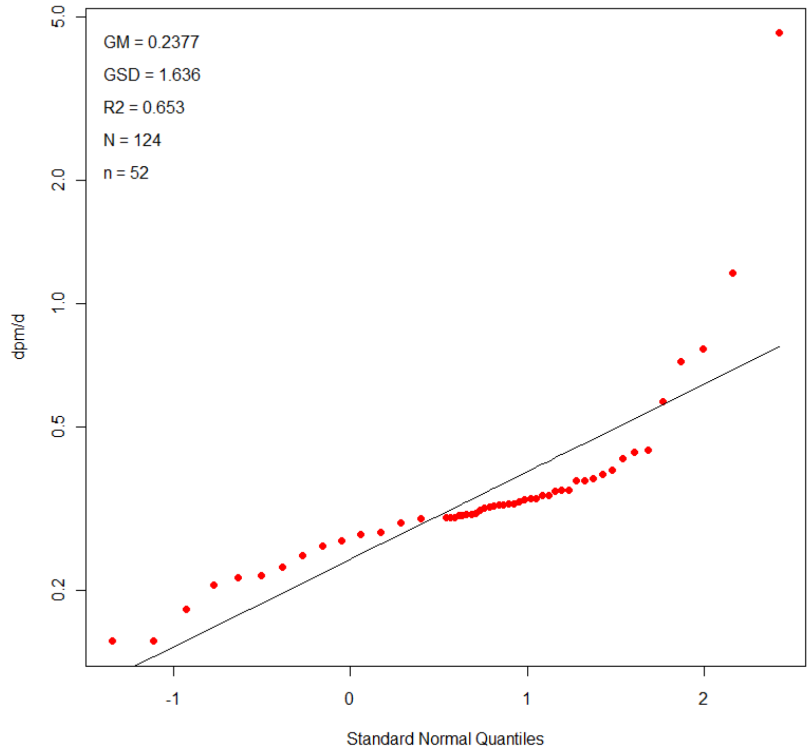

Figure A-41. ROS fit for CTWs, 1970.

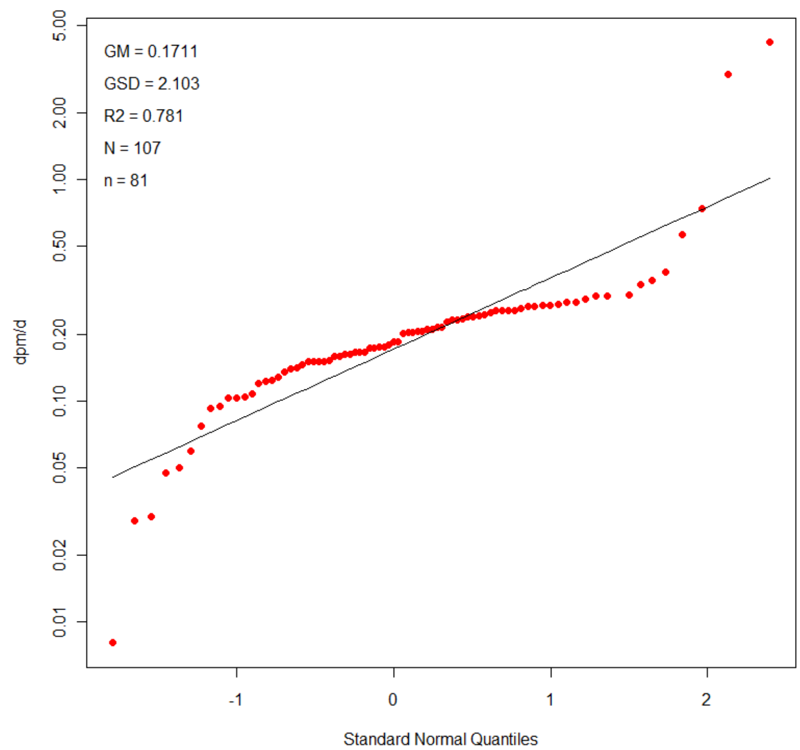

Figure A-42. ROS fit for CTWs, 1971.

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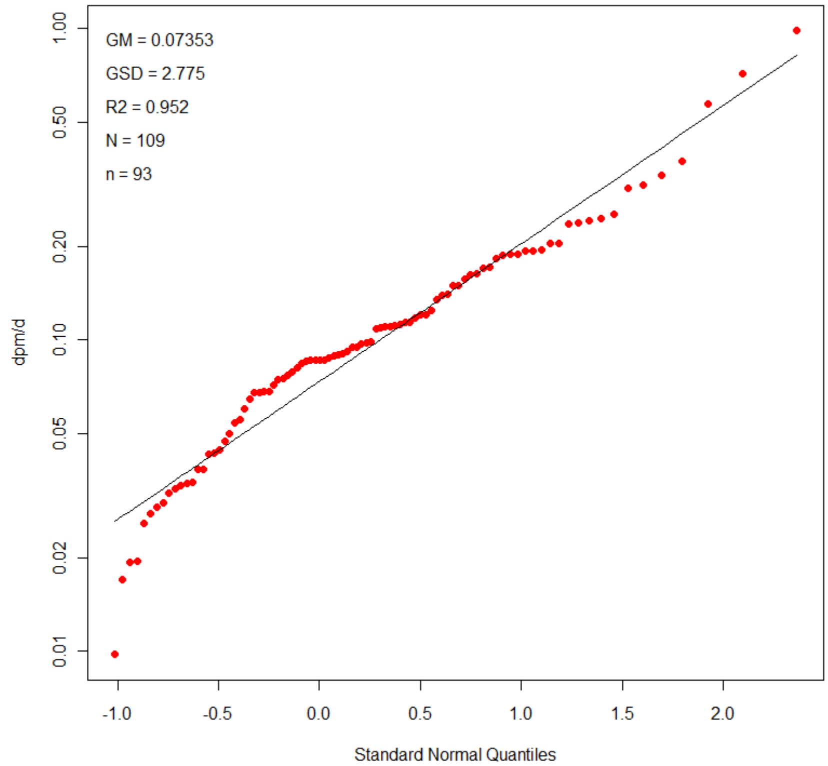

Figure A-43. ROS fit for CTWs, 1972.

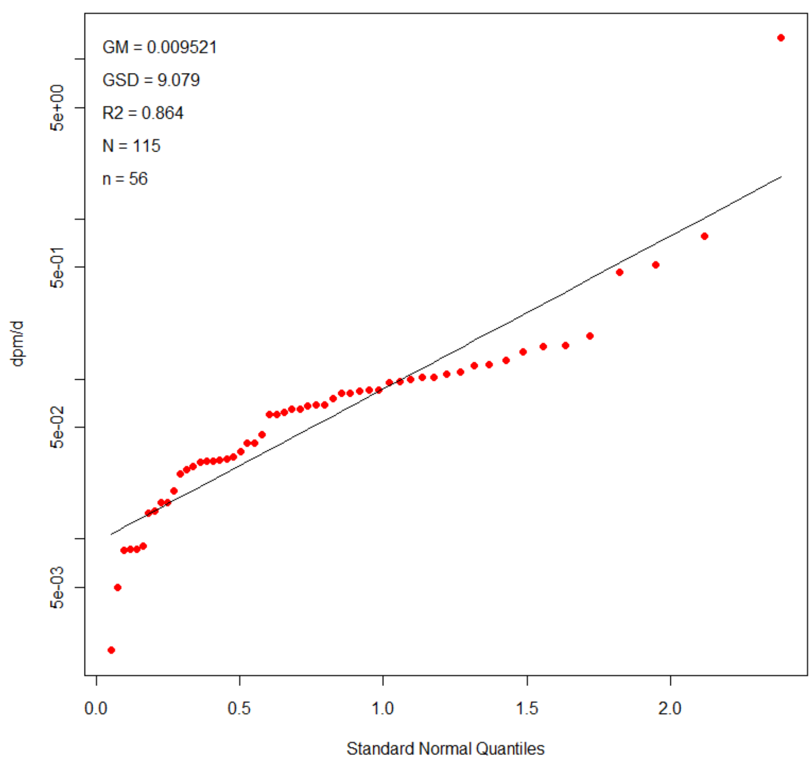

Figure A-44. ROS fit for CTWs, 1973.

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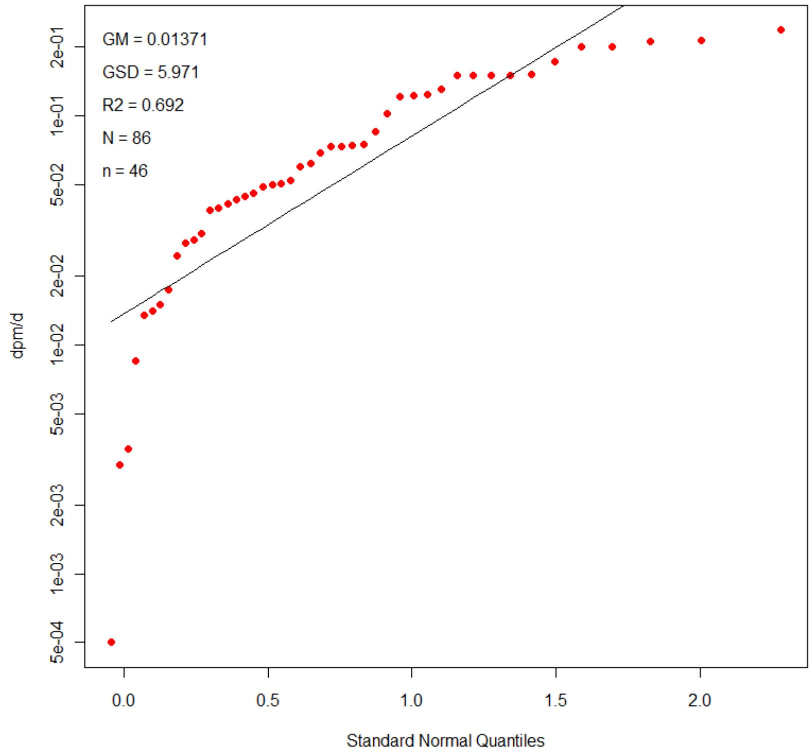

Figure A-45. ROS fit for CTWs, 1974.

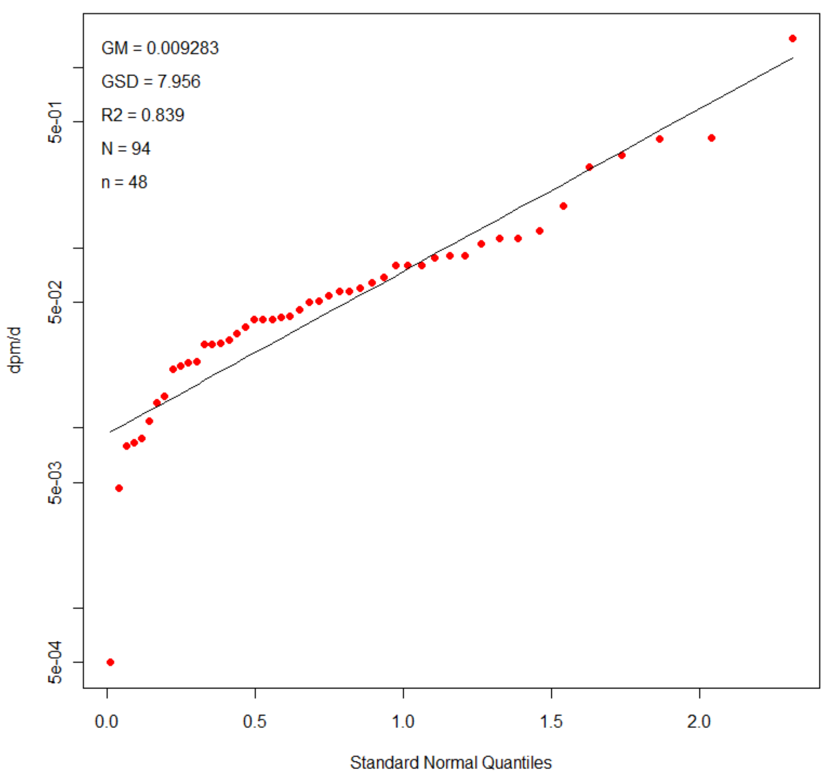

Figure A-46. ROS fit for CTWs, 1975.

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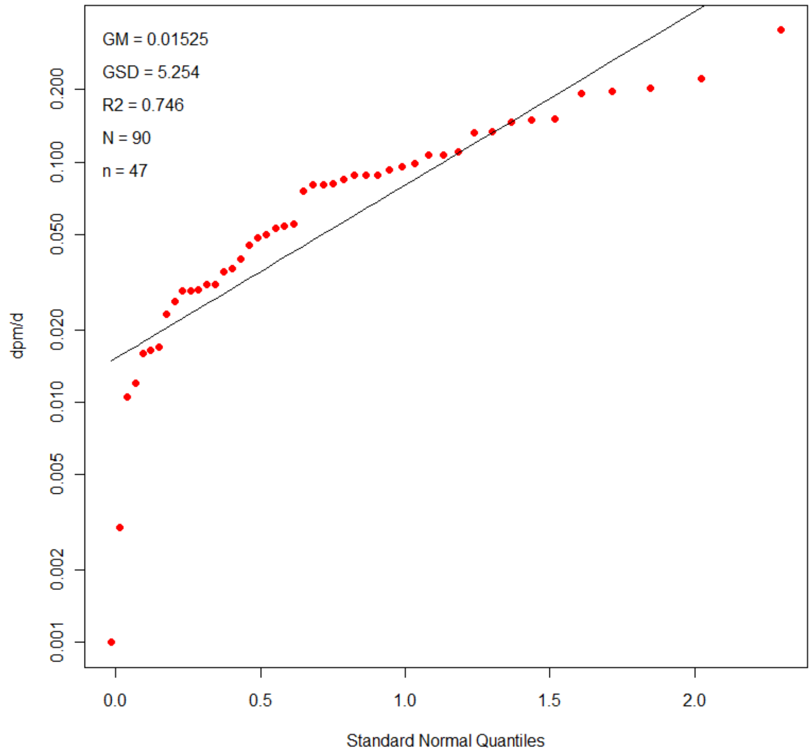

Figure A-47. ROS fit for CTWs, 1976.

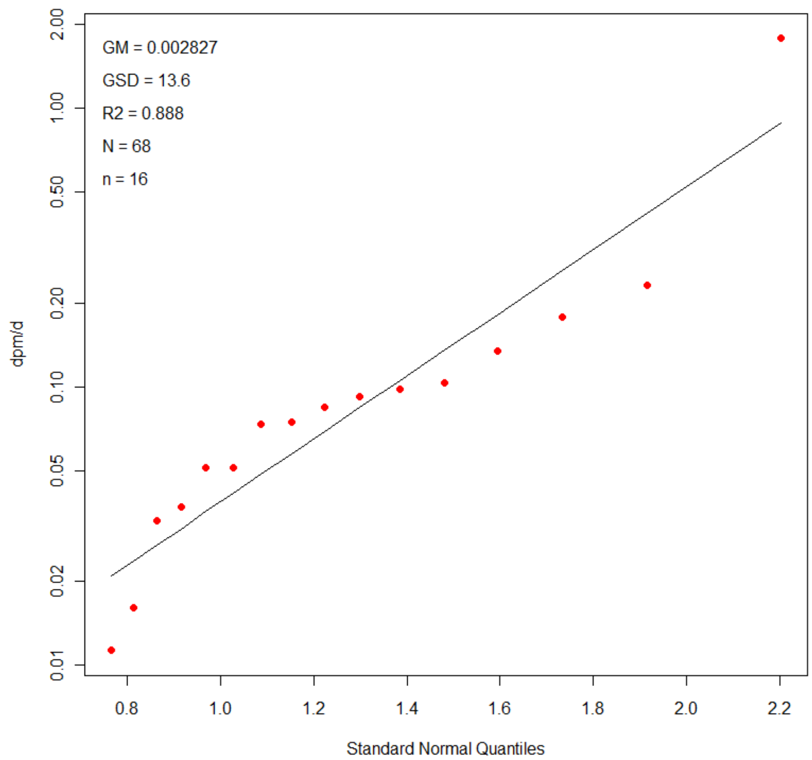

Figure A-48. ROS fit for CTWs, 1977.

ATTACHMENT A
ROS AND EFFECTIVE FIT PLOTS FOR AMWS, CTW, NONCTWS, AND NONCTW+UNKS

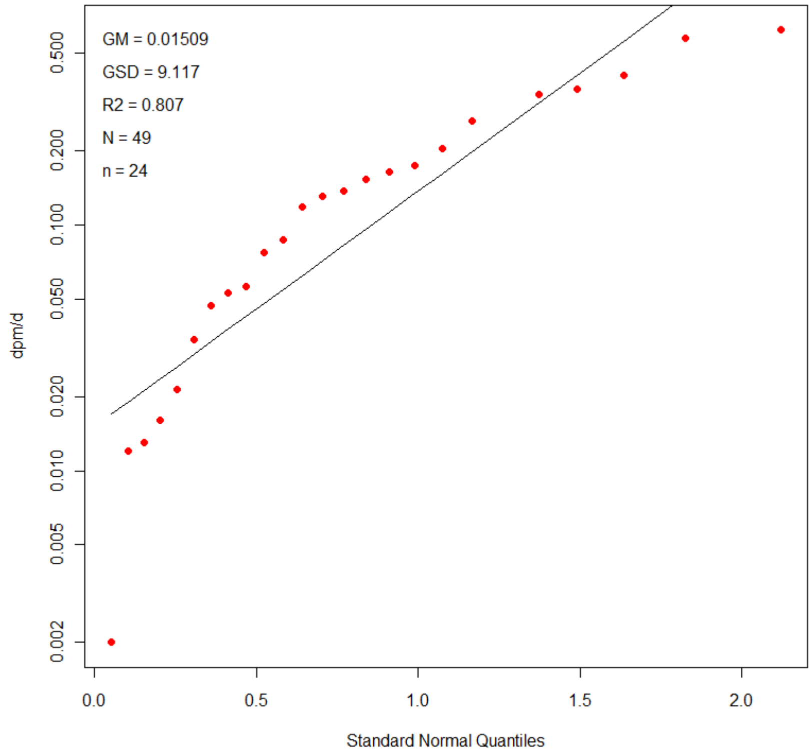

Figure A-49. ROS fit for CTWs, 1978.

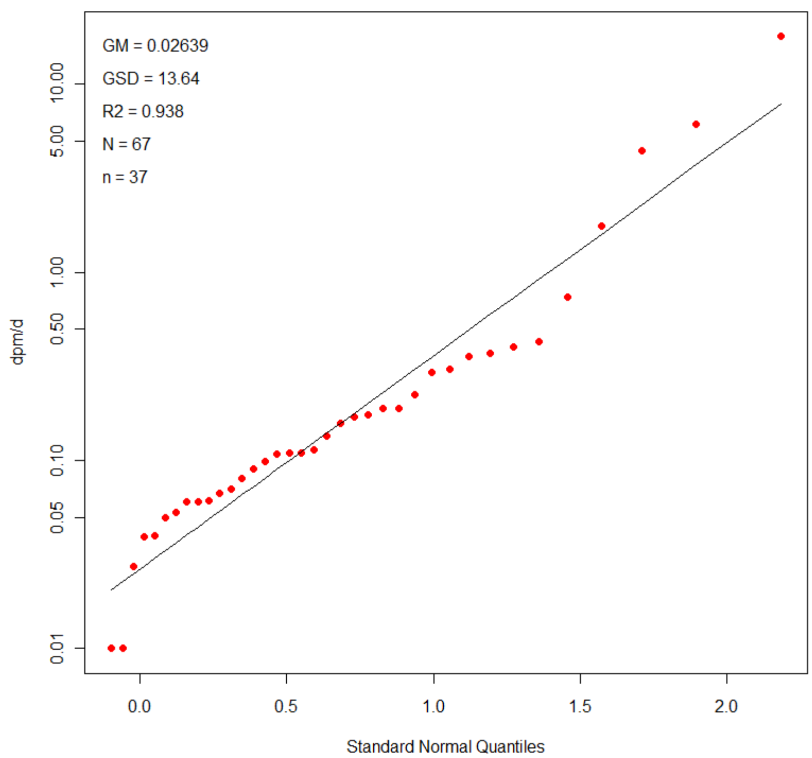

Figure A-50. ROS fit for CTWs, 1979.

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ROS AND EFFECTIVE FIT PLOTS FOR AMWS, CTW, NONCTWS, AND NONCTW+UNKS

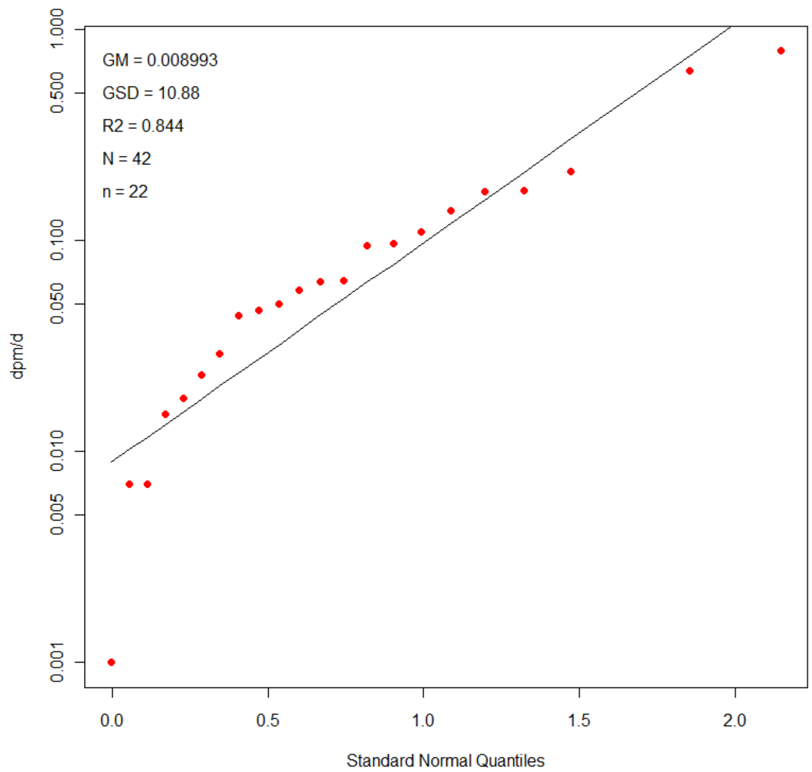

Figure A-51. ROS fit for CTWs, 1980.

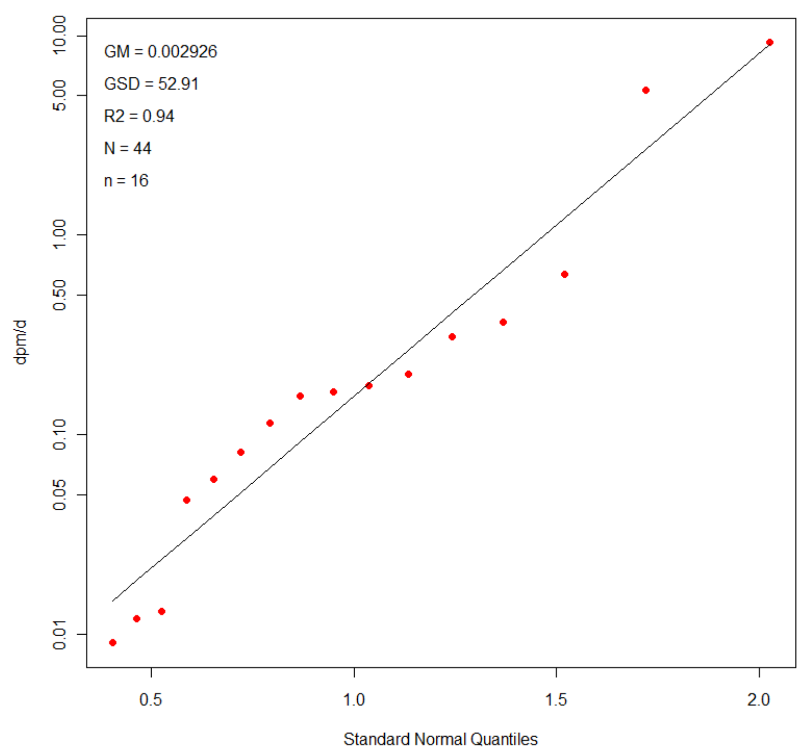

Figure A-52. ROS fit for CTWs, 1981 to 1982.

ATTACHMENT A
ROS AND EFFECTIVE FIT PLOTS FOR AMWS, CTW, NONCTWS, AND NONCTW+UNKS

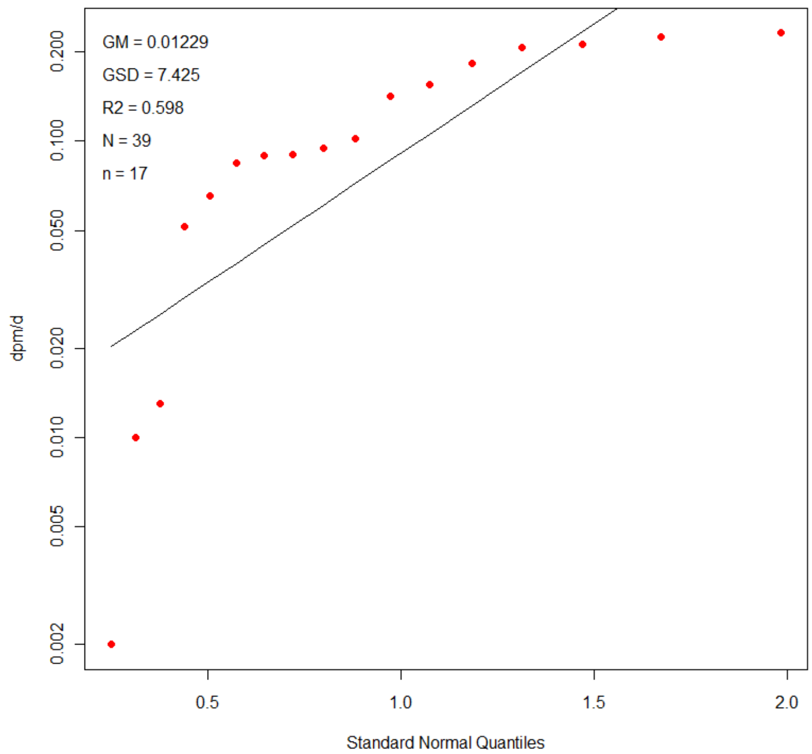

Figure A-53. ROS fit for CTWs, 1983.

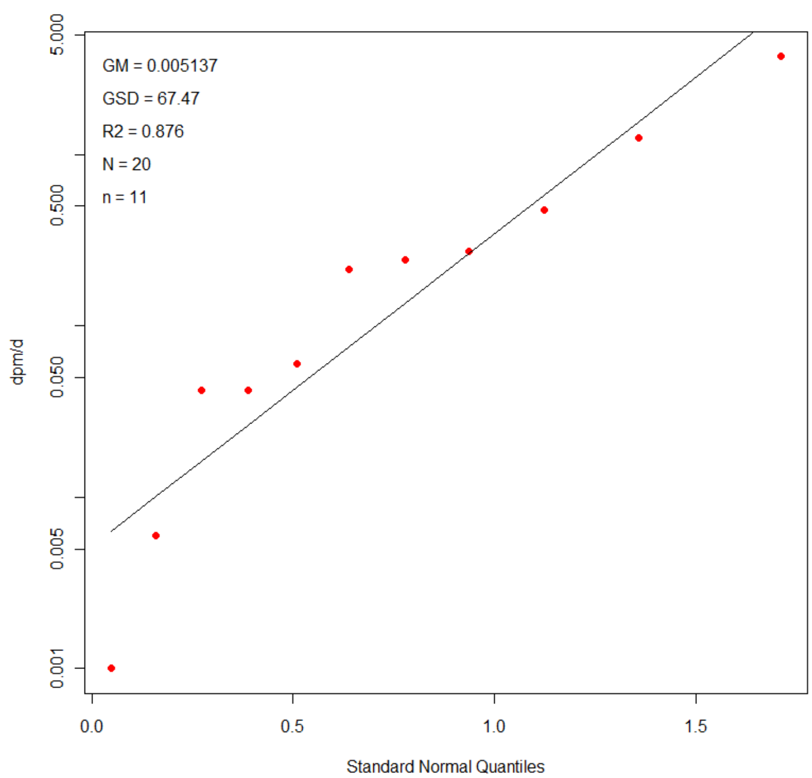

Figure A-54. ROS fit for CTWs, 1984.

ATTACHMENT A
ROS AND EFFECTIVE FIT PLOTS FOR AMWS, CTW, NONCTWS, AND NONCTW+UNKS

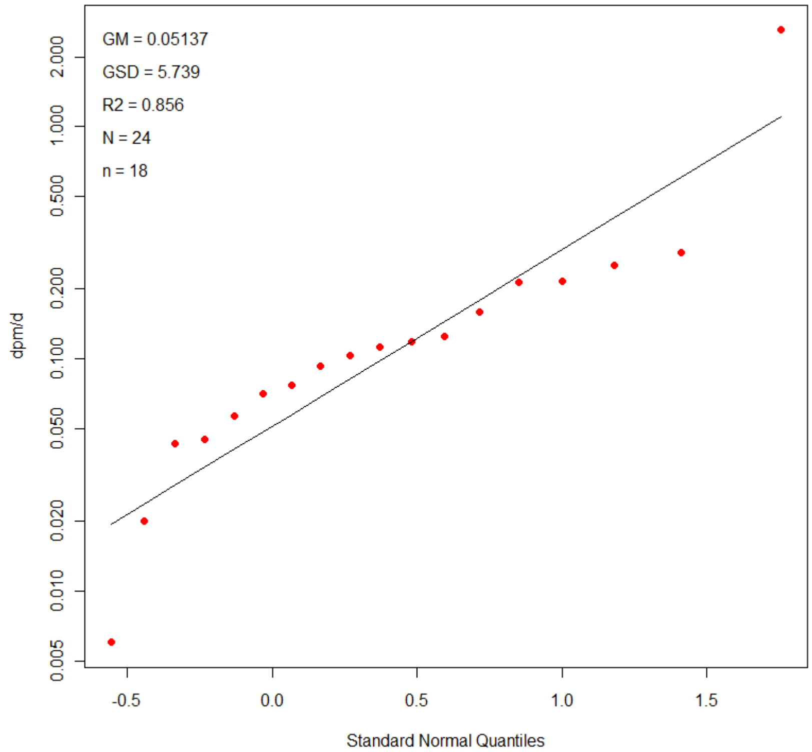

Figure A-55. ROS fit for CTWs, 1985.

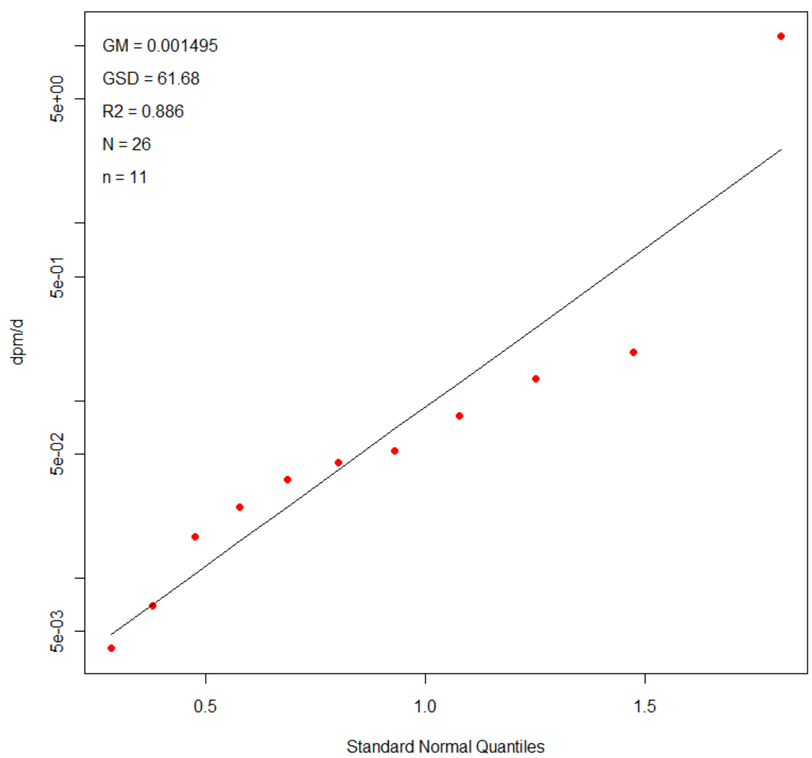

Figure A-56. ROS fit for CTWs, 1986.

ATTACHMENT A
ROS AND EFFECTIVE FIT PLOTS FOR AMWS, CTW, NONCTWS, AND NONCTW+UNKS

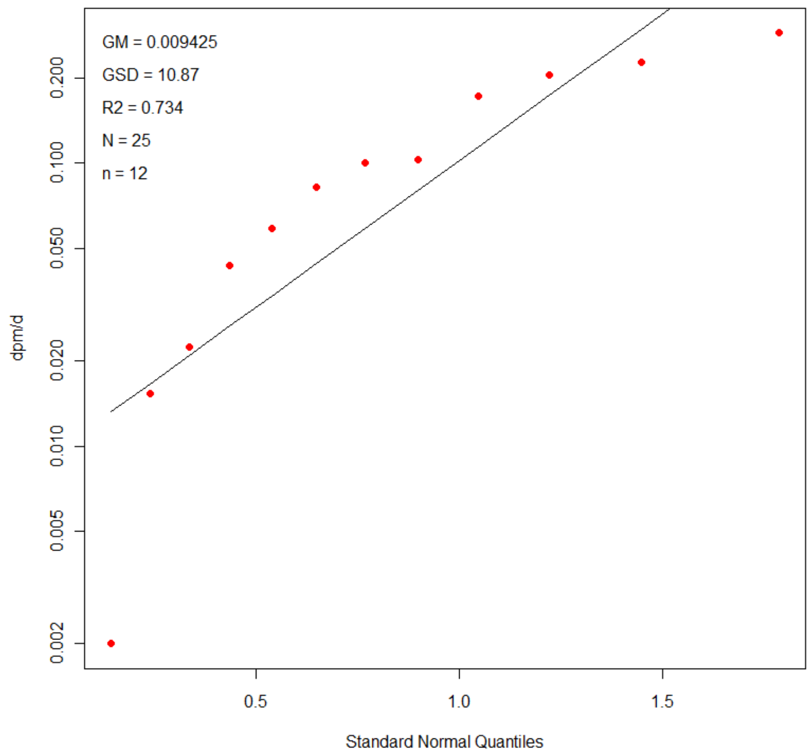

Figure A-57. ROS fit for CTWs, 1987 to 1989.

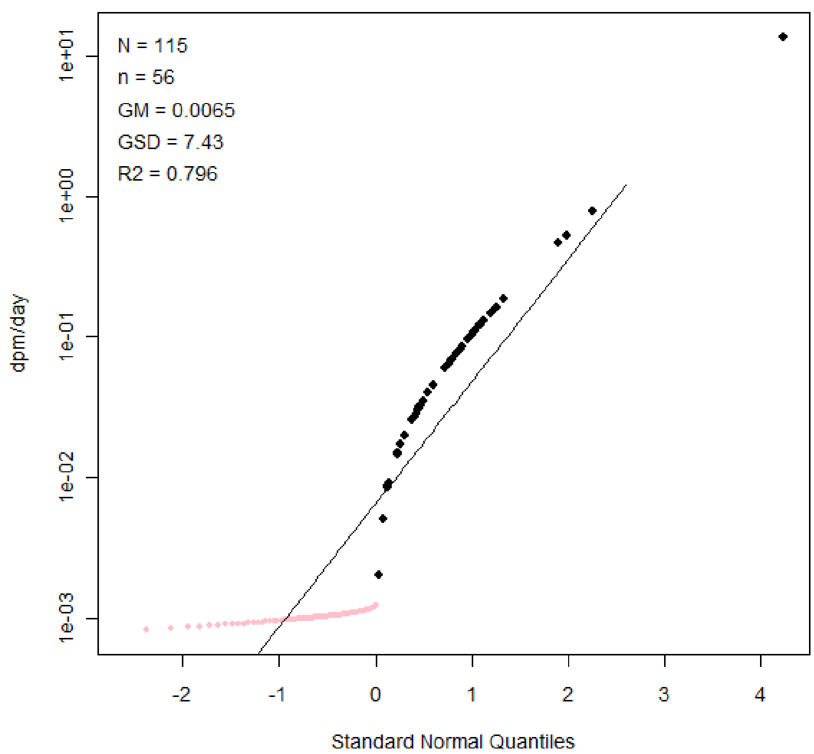

Figure A-58. Effective fit for CTWs, 1973.

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ROS AND EFFECTIVE FIT PLOTS FOR AMWS, CTW, NONCTWS, AND NONCTW+UNKS

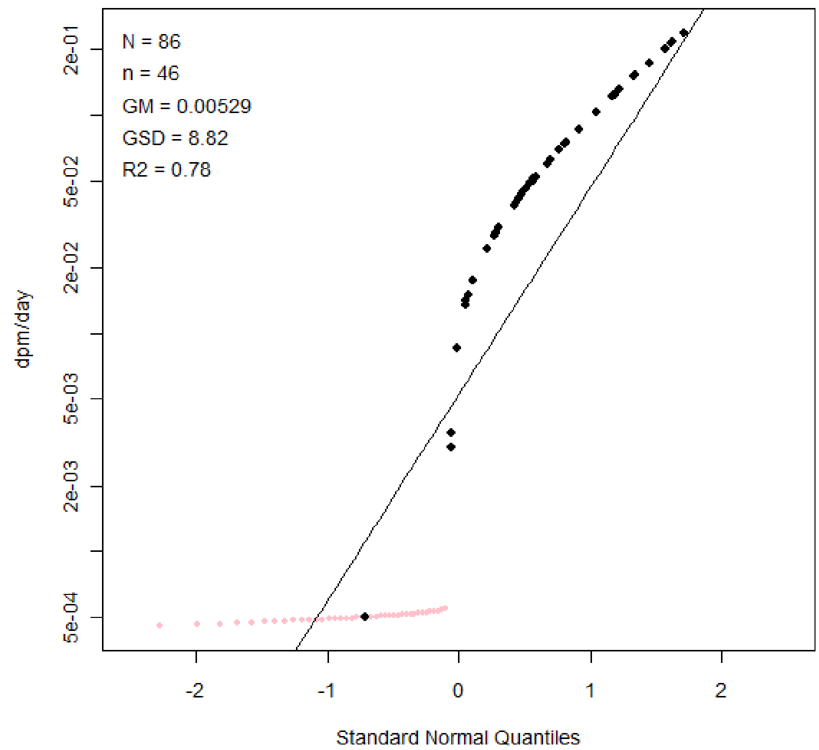

Figure A-59. Effective fit for CTWs, 1974.

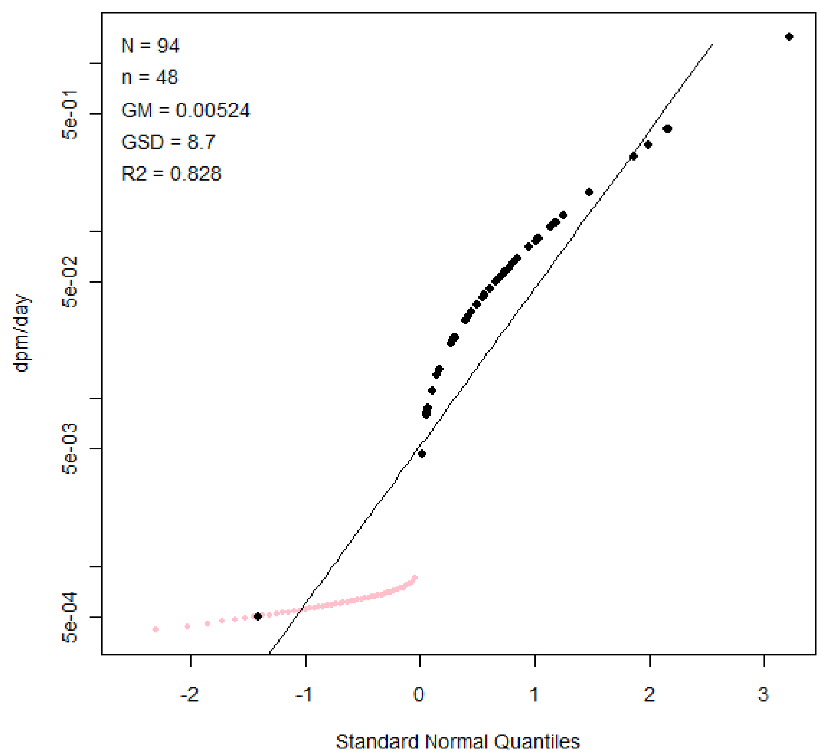

Figure A-60. Effective fit for CTWs, 1975.

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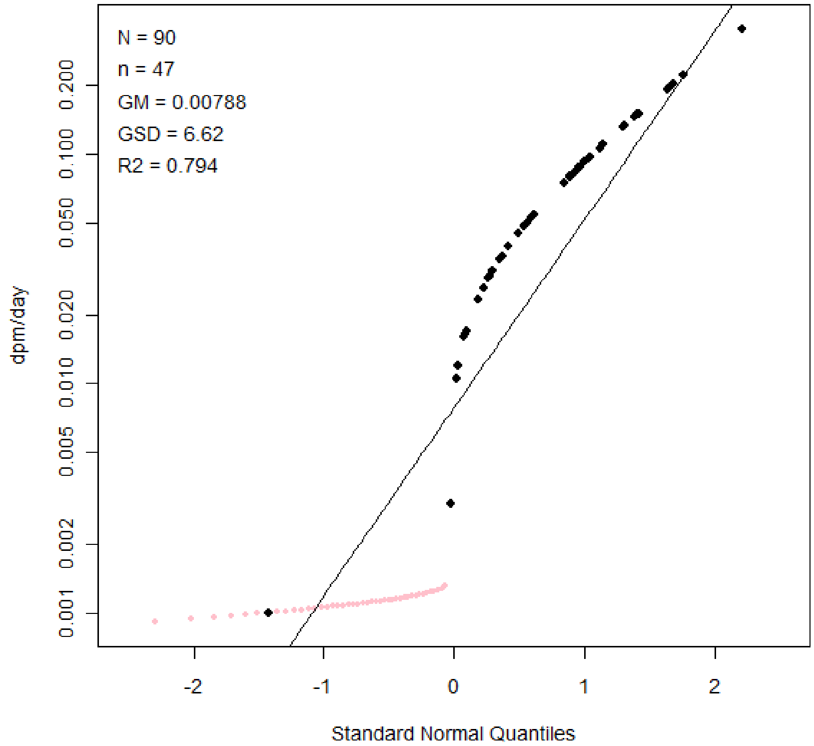

Figure A-61. Effective fit for CTWs, 1976.

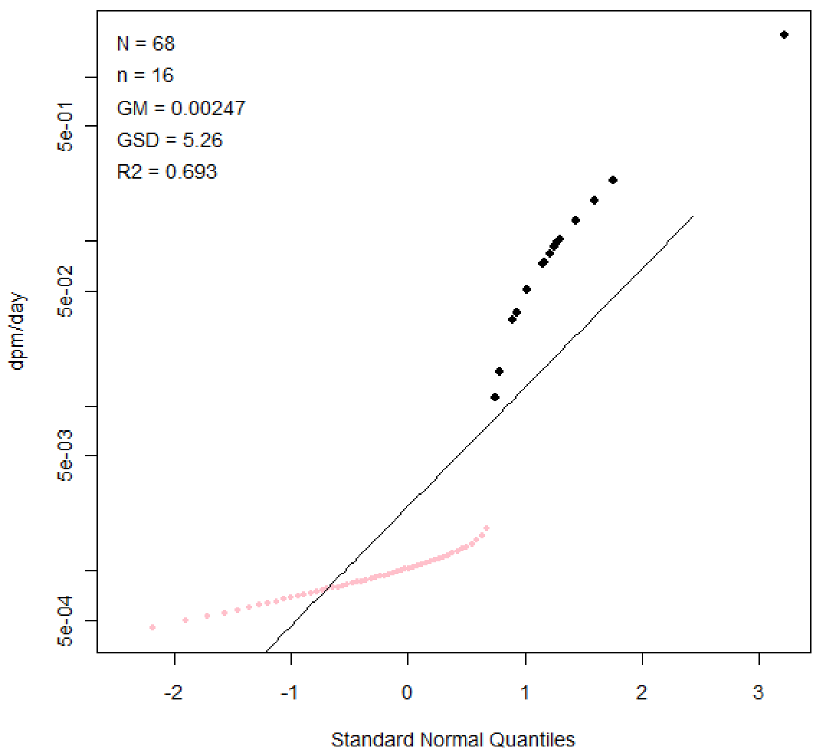

Figure A-62. Effective fit for CTWs, 1977.

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ROS AND EFFECTIVE FIT PLOTS FOR AMWS, CTW, NONCTWS, AND NONCTW+UNKS

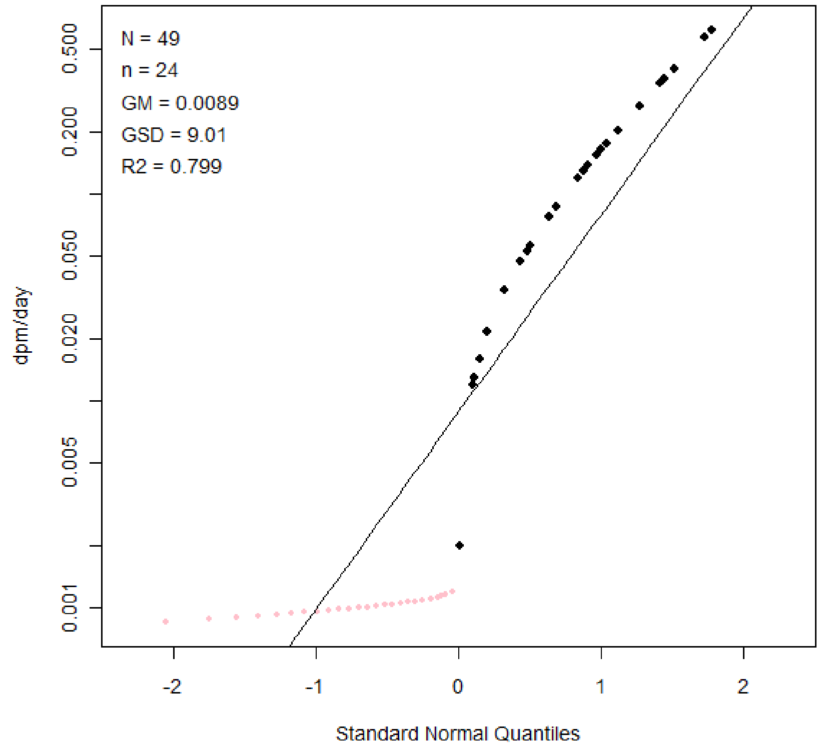

Figure A-63. Effective fit for CTWs, 1978.

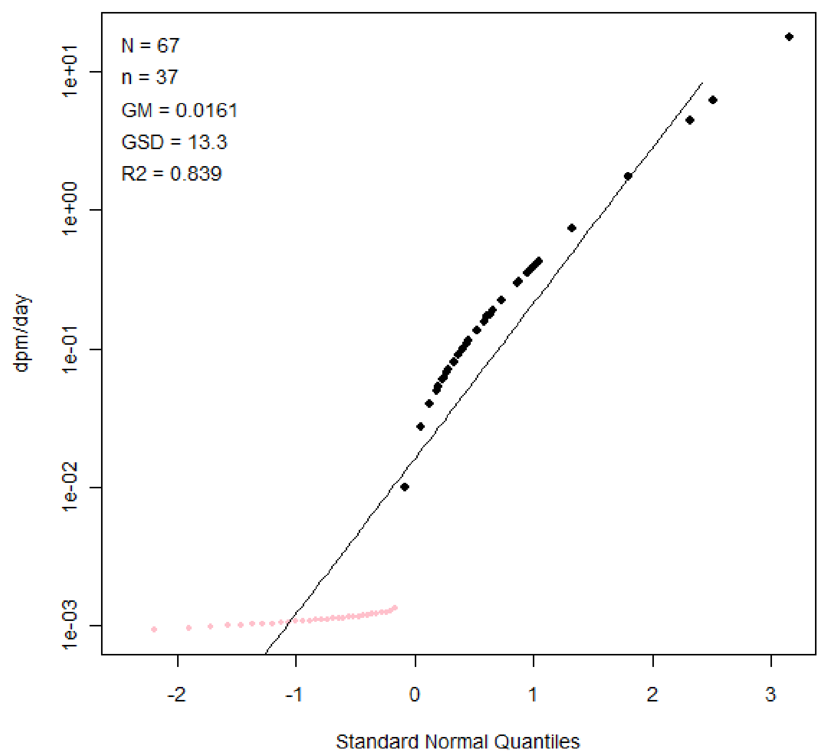

Figure A-64. Effective fit for CTWs, 1979.

ATTACHMENT A
ROS AND EFFECTIVE FIT PLOTS FOR AMWS, CTW, NONCTWS, AND NONCTW+UNKS

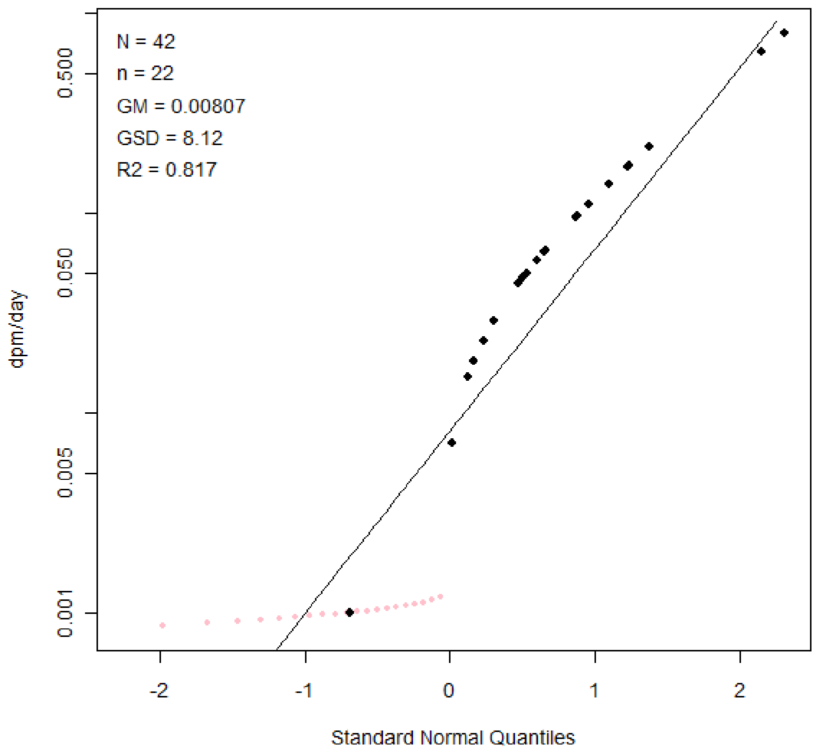

Figure A-65. Effective fit for CTWs, 1980.

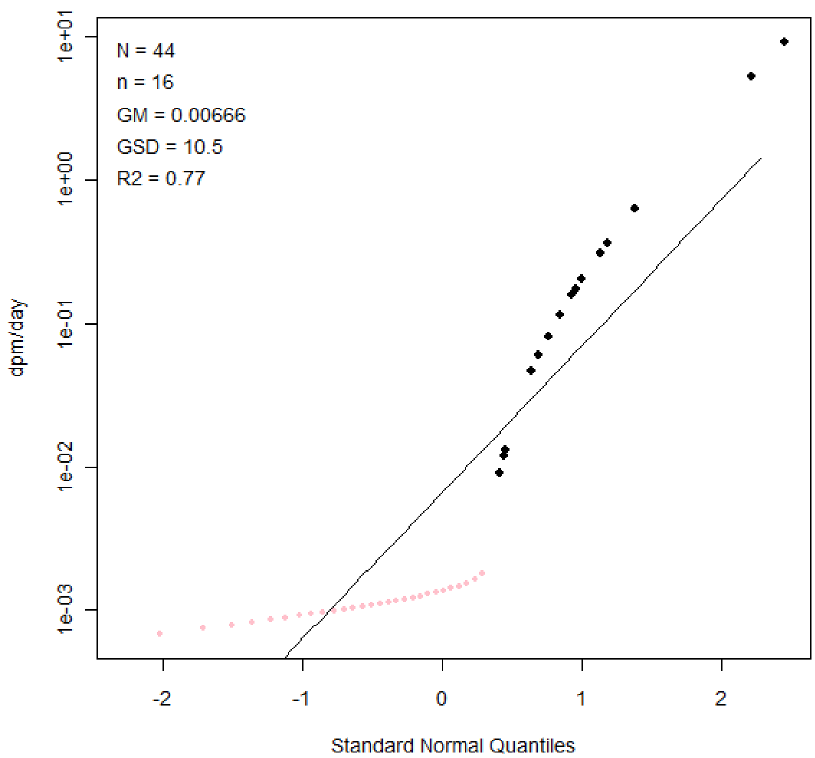

Figure A-66. Effective fit for CTWs, 1981 to 1982.

ATTACHMENT A
ROS AND EFFECTIVE FIT PLOTS FOR AMWS, CTW, NONCTWS, AND NONCTW+UNKS

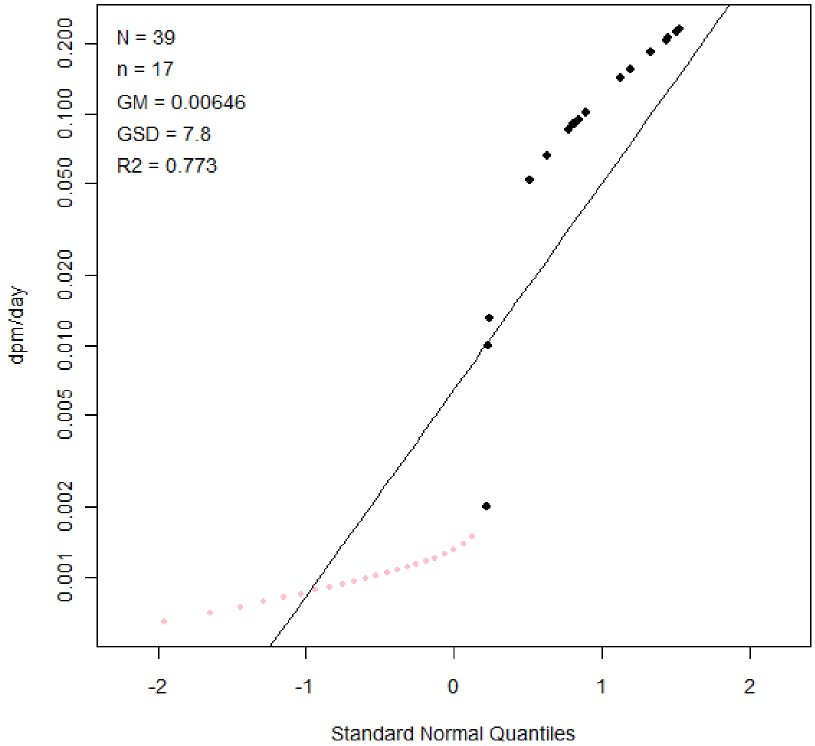

Figure A-67. Effective fit for CTWs, 1983.

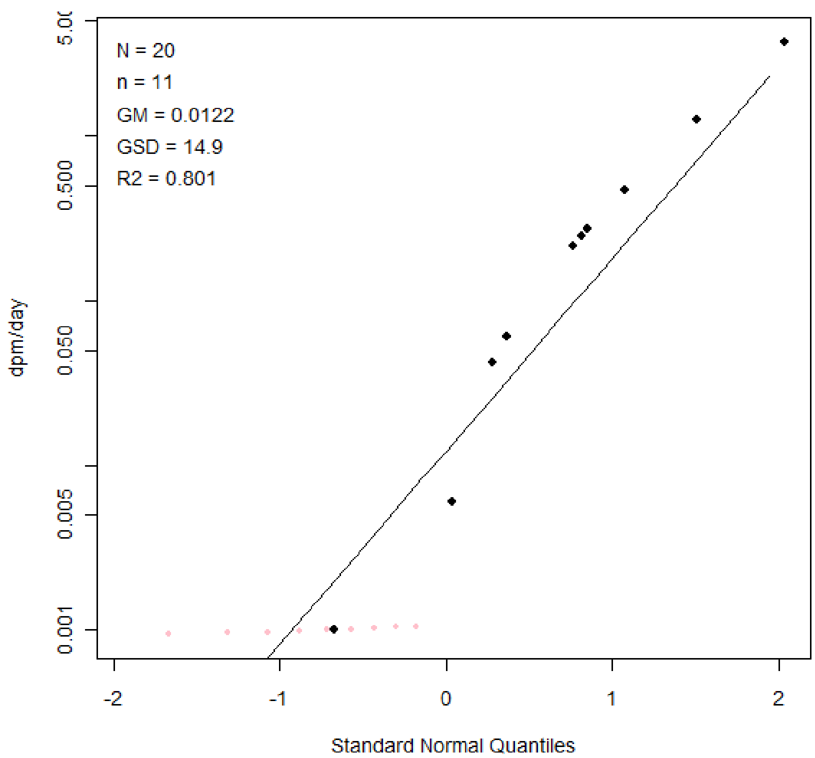

Figure A-68. Effective fit for CTWs, 1984.

ATTACHMENT A
ROS AND EFFECTIVE FIT PLOTS FOR AMWS, CTW, NONCTWS, AND NONCTW+UNKS

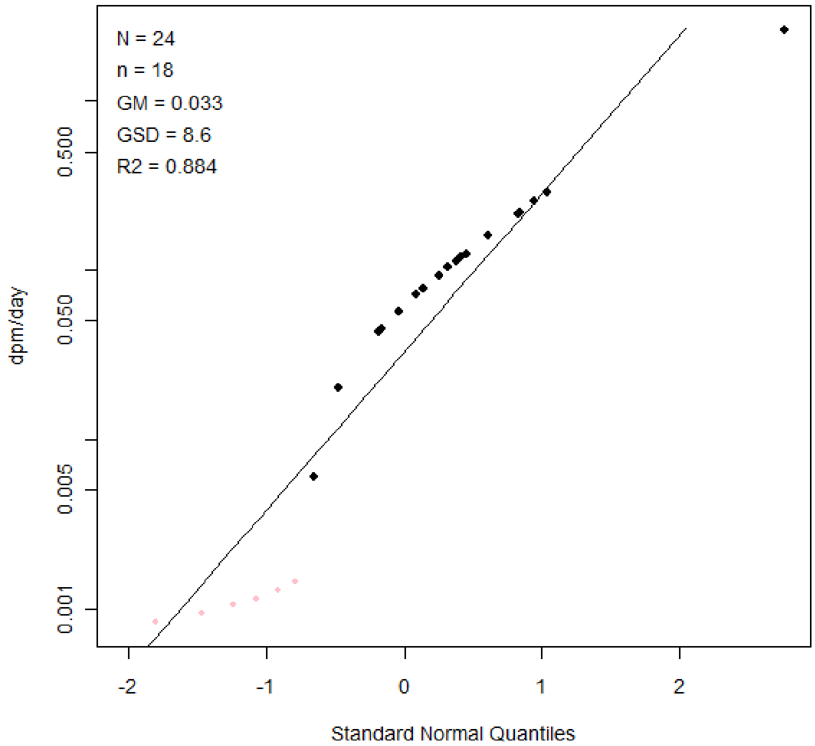

Figure A-69. Effective fit for CTWs, 1985.

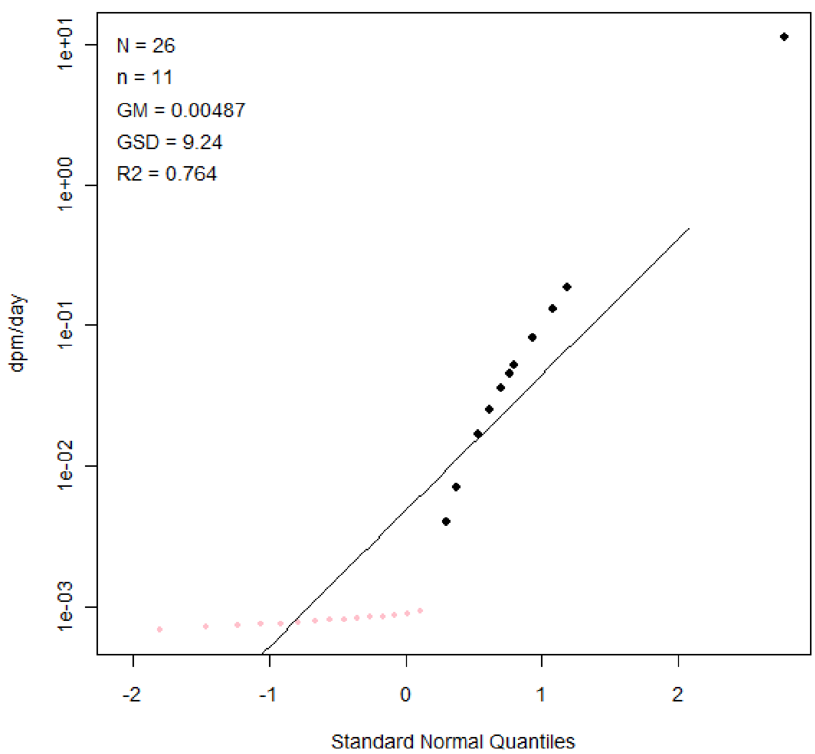

Figure A-70. Effective fit for CTWs, 1986.

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ROS AND EFFECTIVE FIT PLOTS FOR AMWS, CTW, NONCTWS, AND NONCTW+UNKS

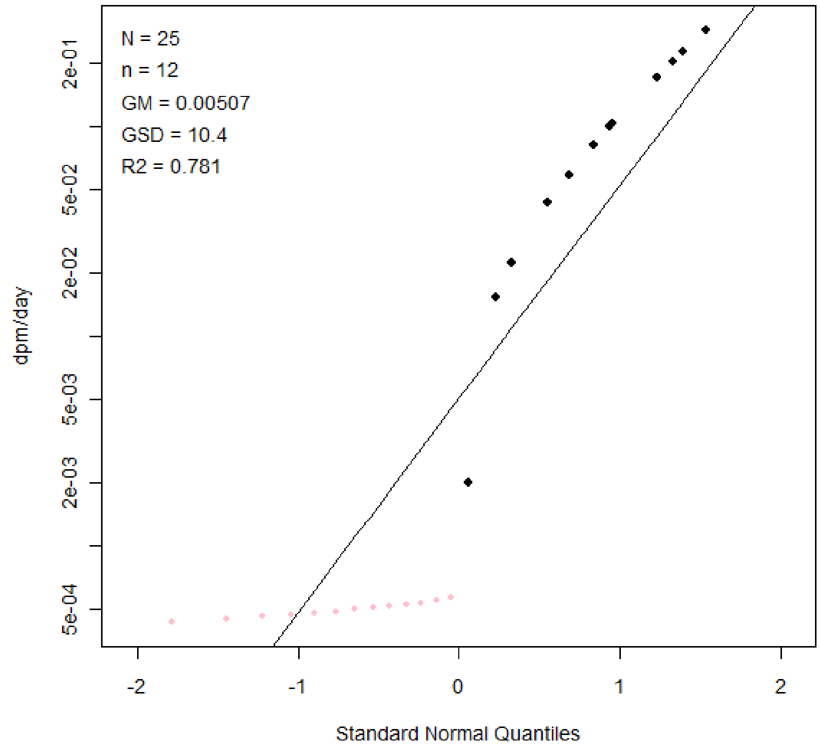

Figure A-71. Effective fit for CTWs, 1987 to 1989.

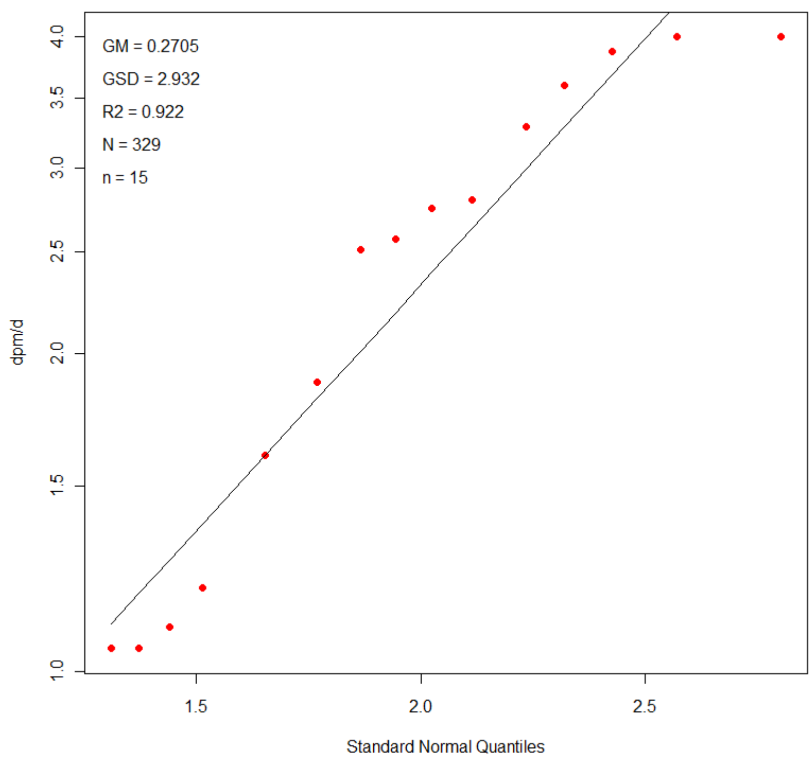

Figure A-72. ROS fit for nonCTWs, 1966 to 1968.

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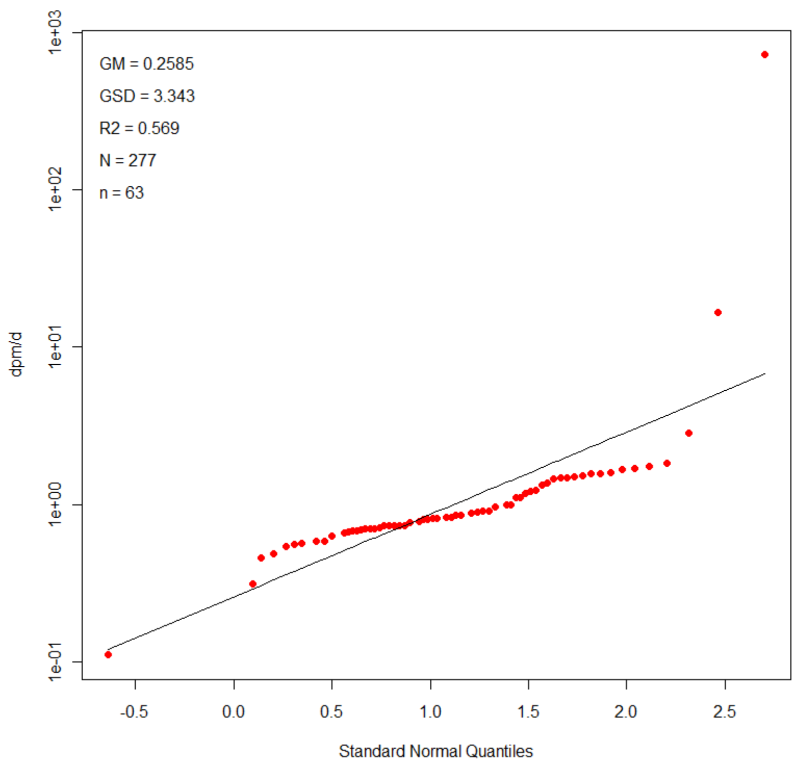

Figure A-73. ROS fit for nonCTWs, 1969.

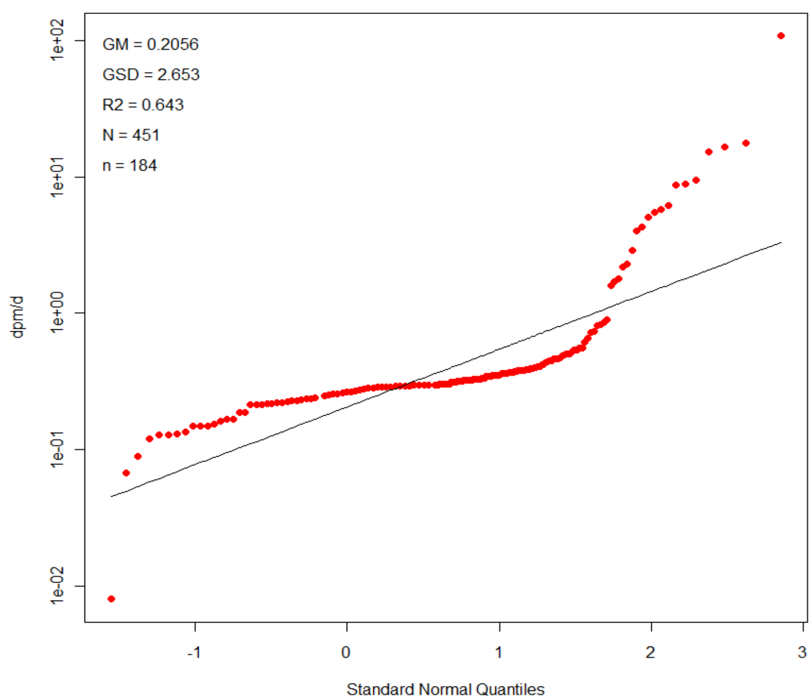

Figure A-74. ROS fit for nonCTWs, 1970.

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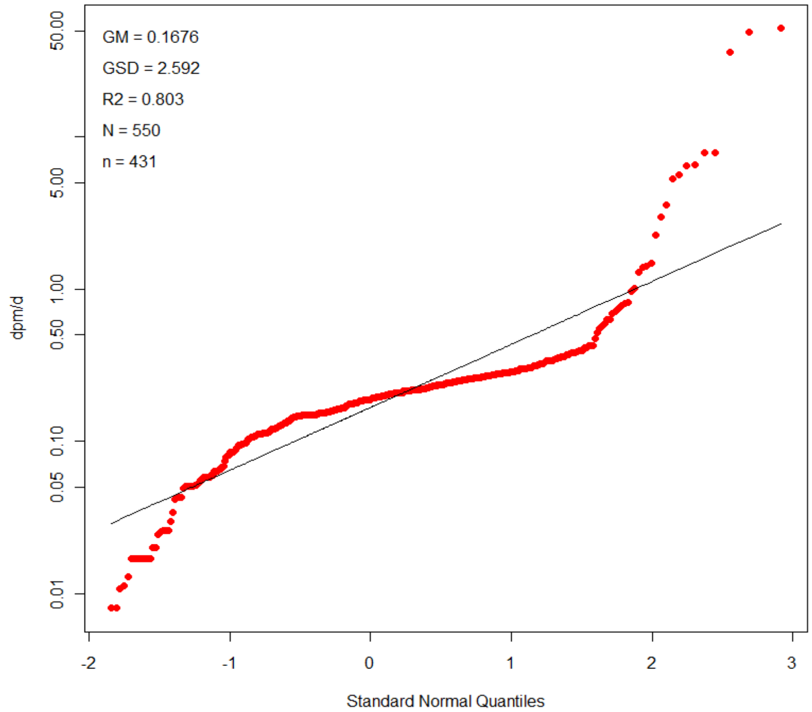

Figure A-75. ROS fit for nonCTWs, 1971.

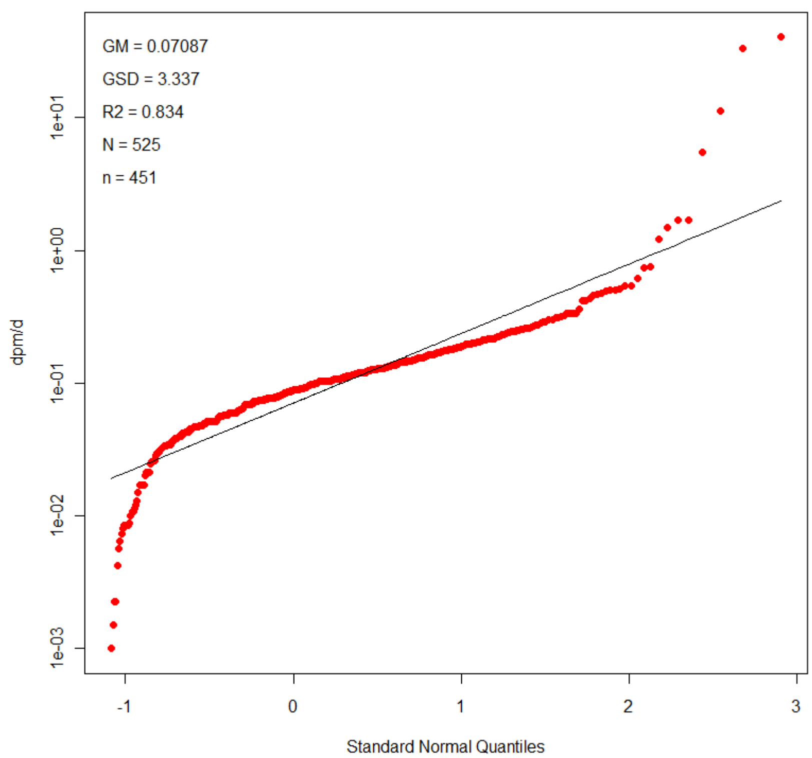

Figure A-76. ROS fit for nonCTWs, 1972.

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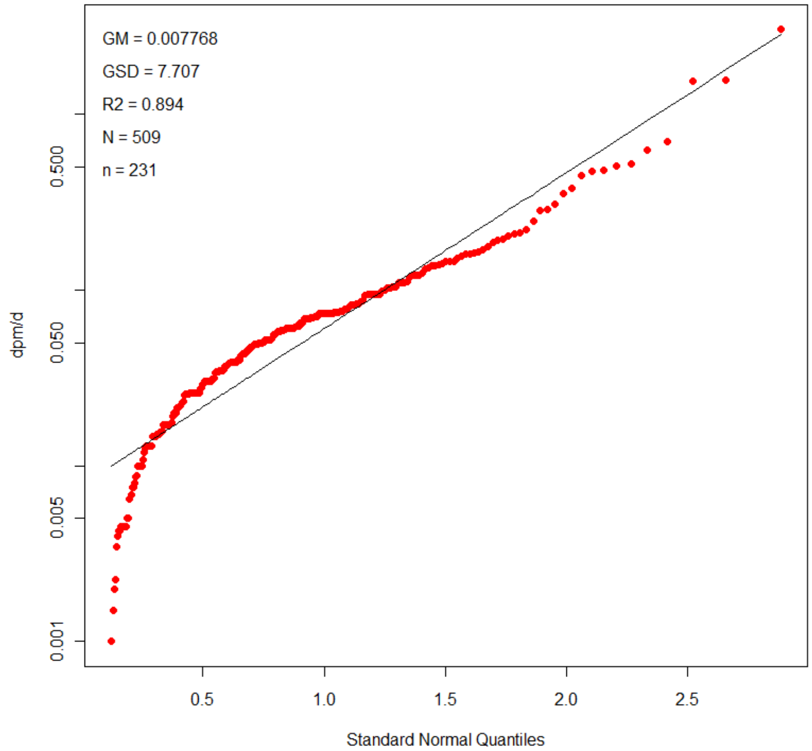

Figure A-77. ROS fit for nonCTWs, 1973.

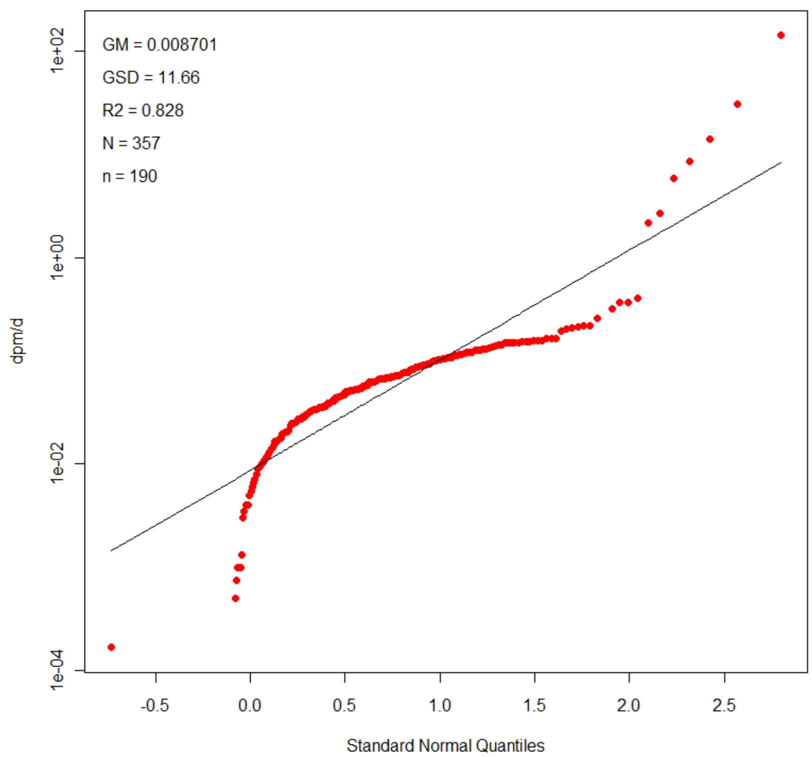

Figure A-78. ROS fit for nonCTWs, 1974.

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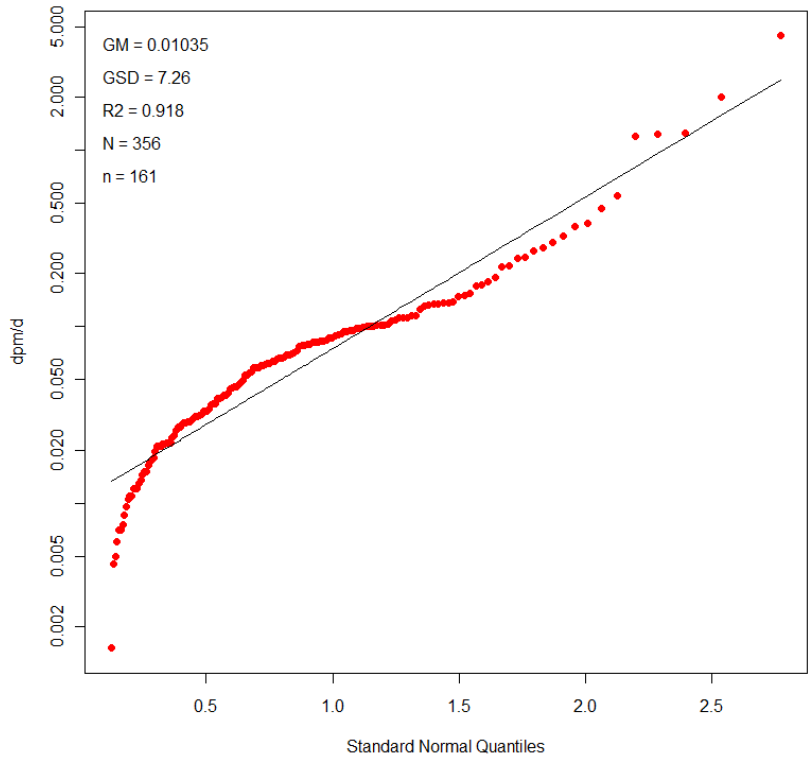

Figure A-79. ROS fit for nonCTWs, 1975.

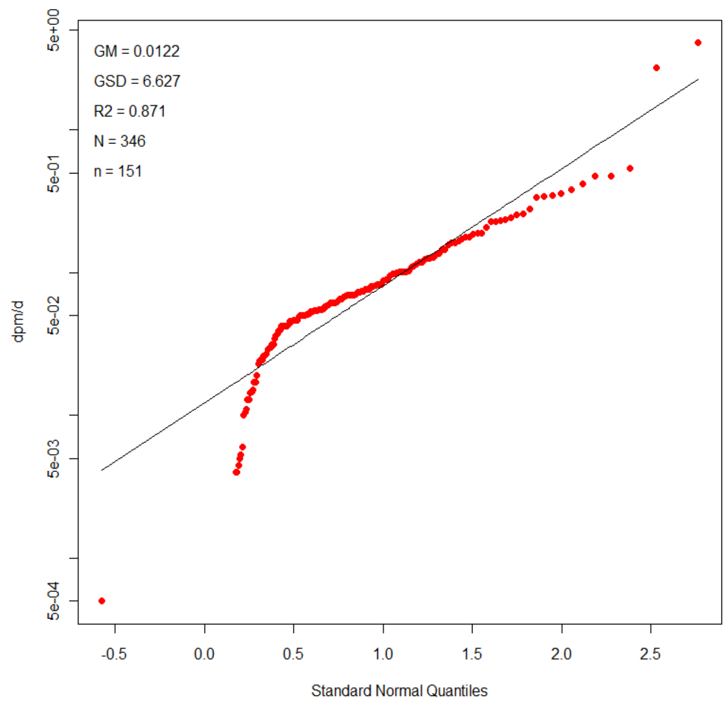

Figure A-80. ROS fit for nonCTWs, 1976.

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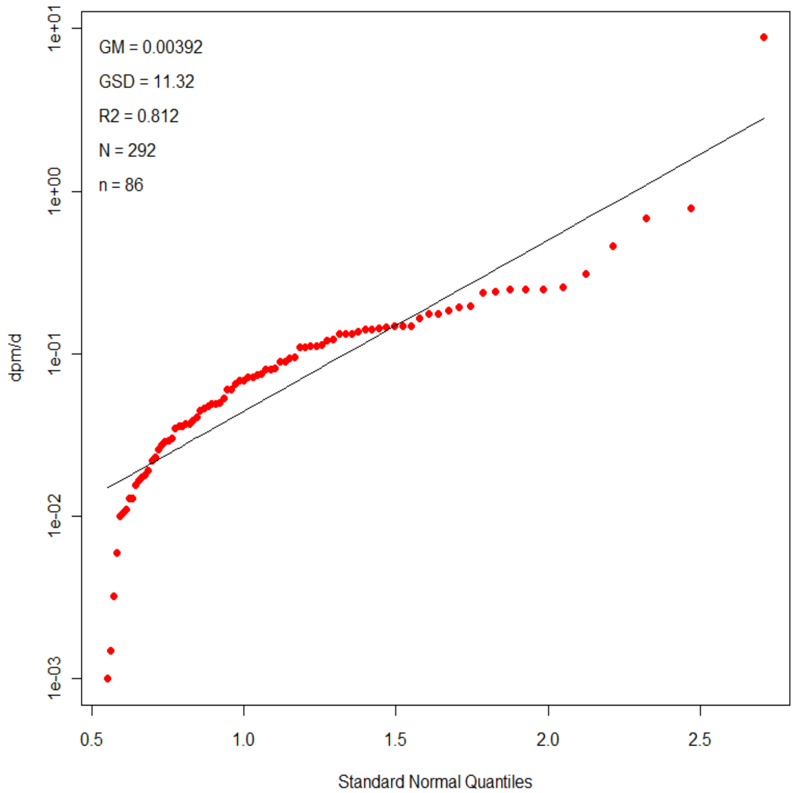

Figure A-81. ROS fit for nonCTWs, 1977.

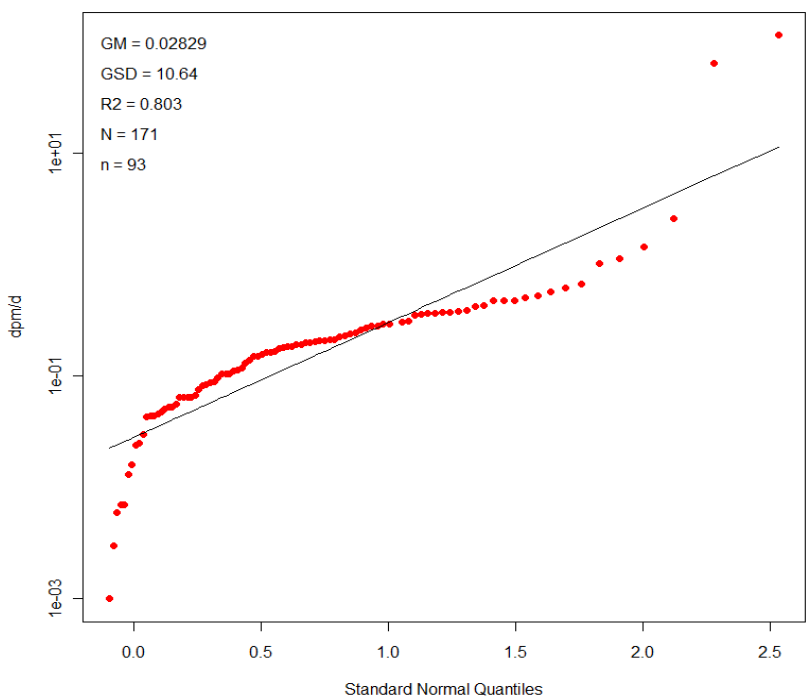

Figure A-82. ROS fit for nonCTWs, 1978.

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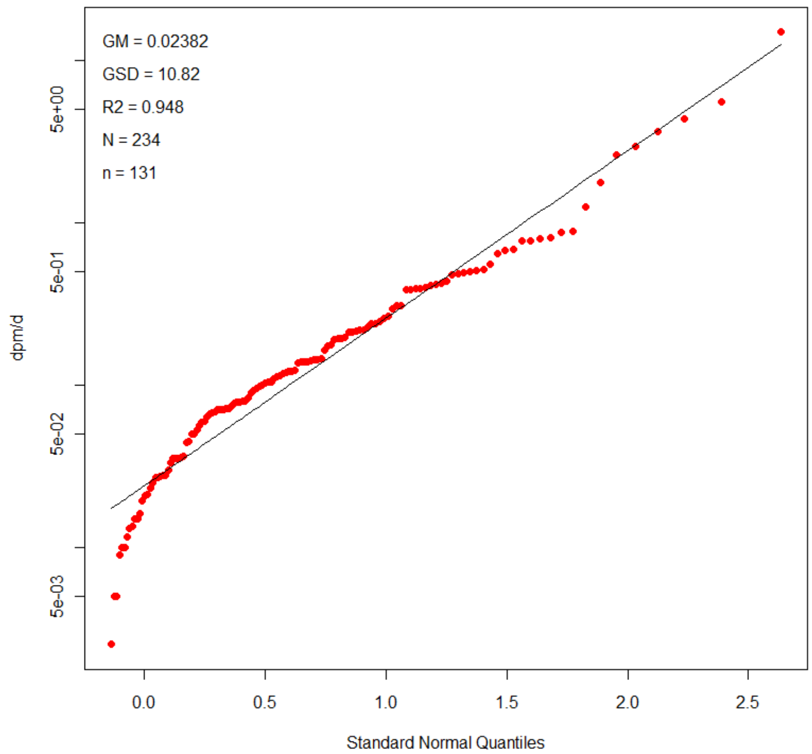

Figure A-83. ROS fit for nonCTWs, 1979.

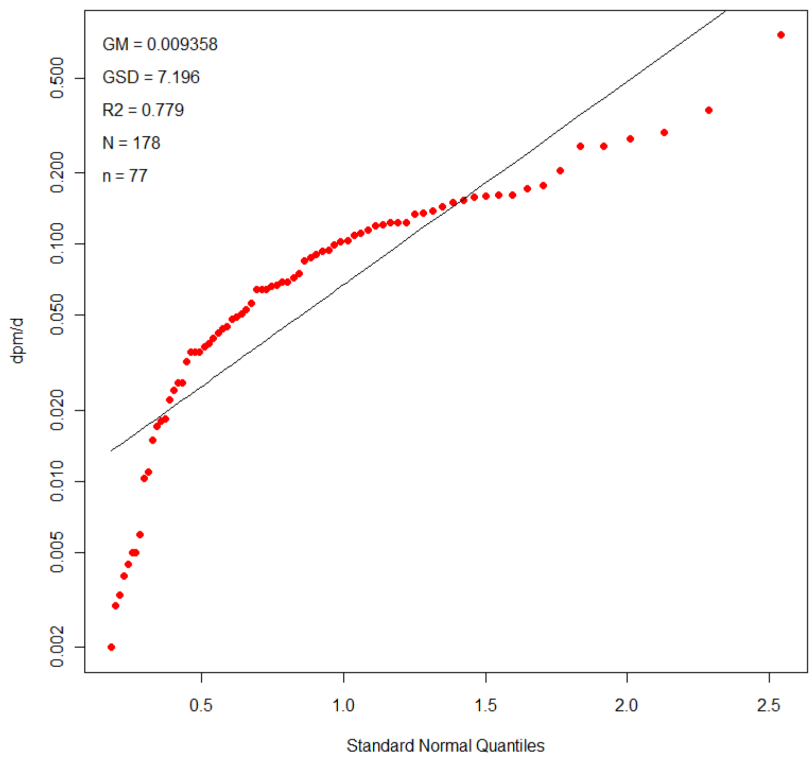

Figure A-84. ROS fit for nonCTWs, 1980.

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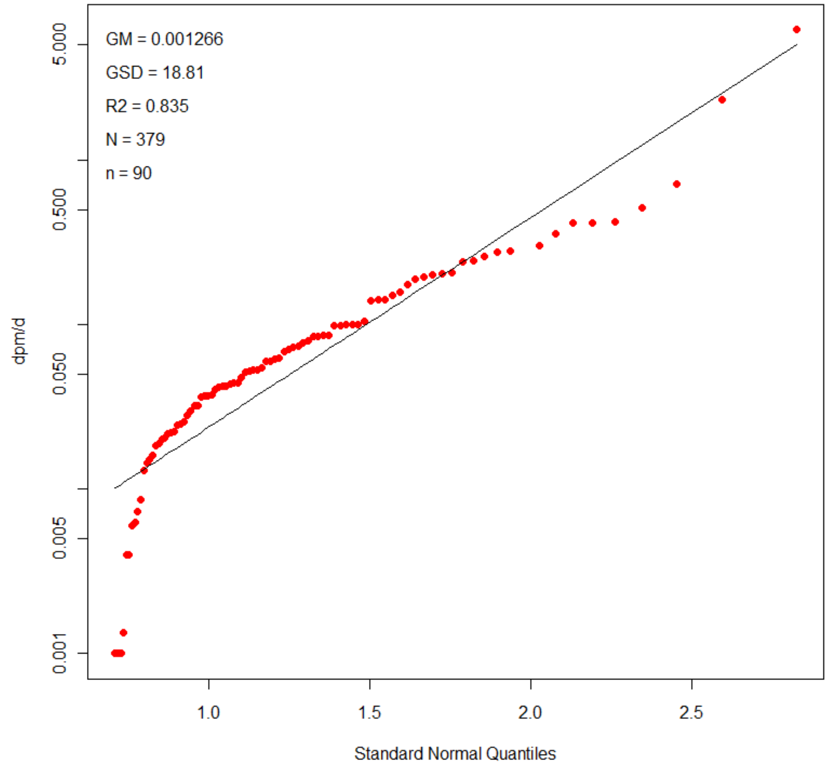

Figure A-85. ROS fit for nonCTWs, 1981 to 1982.

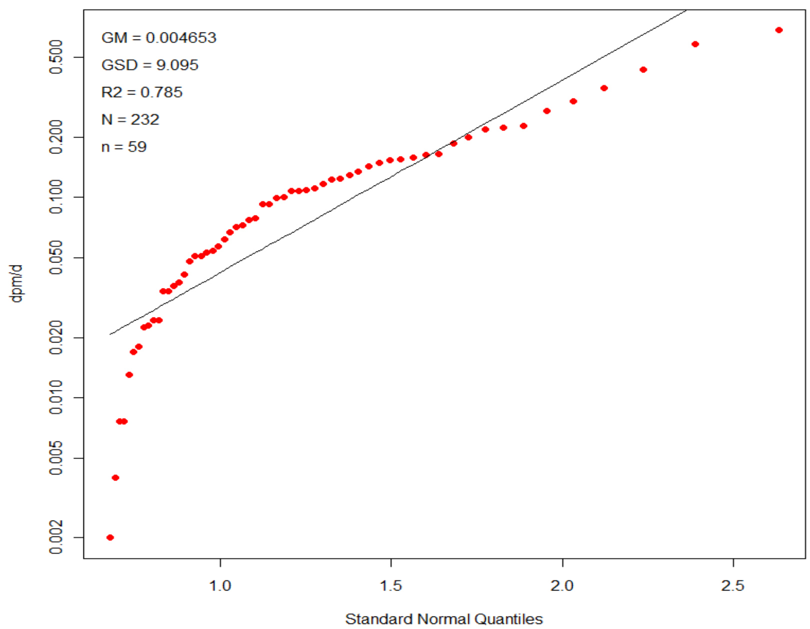

Figure A-86. ROS fit for nonCTWs, 1983.

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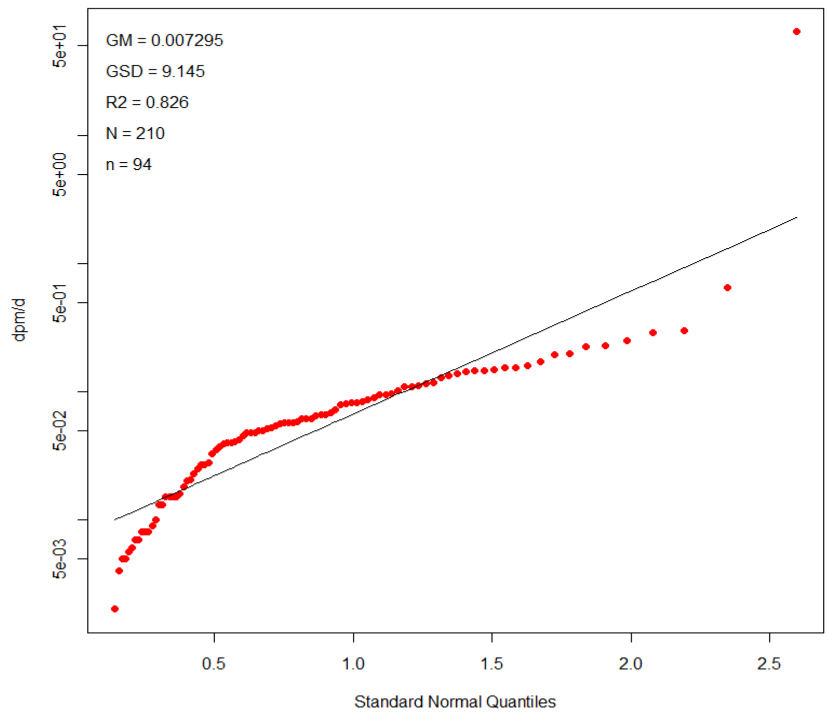

Figure A-87. ROS fit for nonCTWs, 1984.

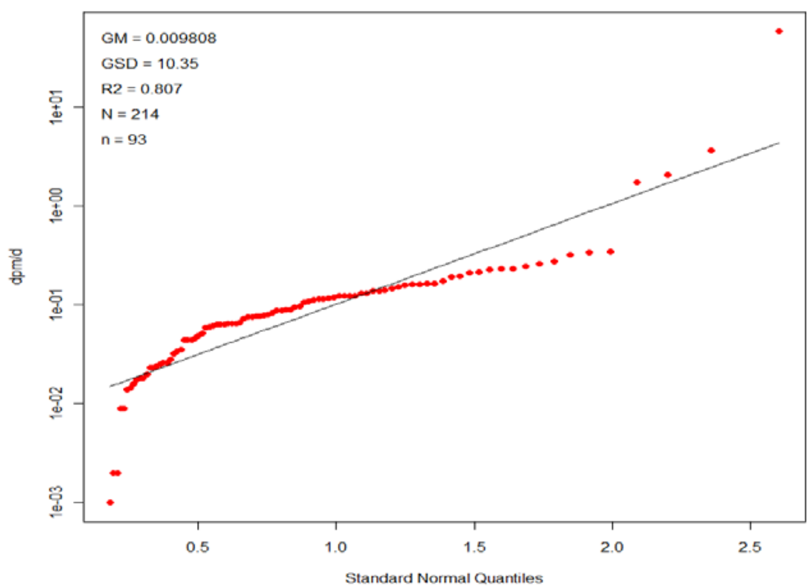

Figure A-88. ROS fit for nonCTWs, 1985.

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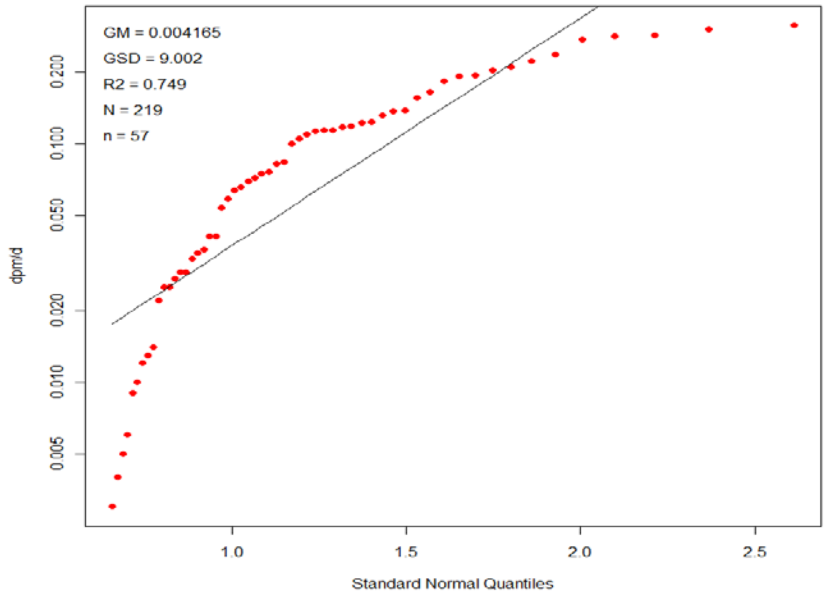

Figure A-89. ROS fit for nonCTWs, 1986.

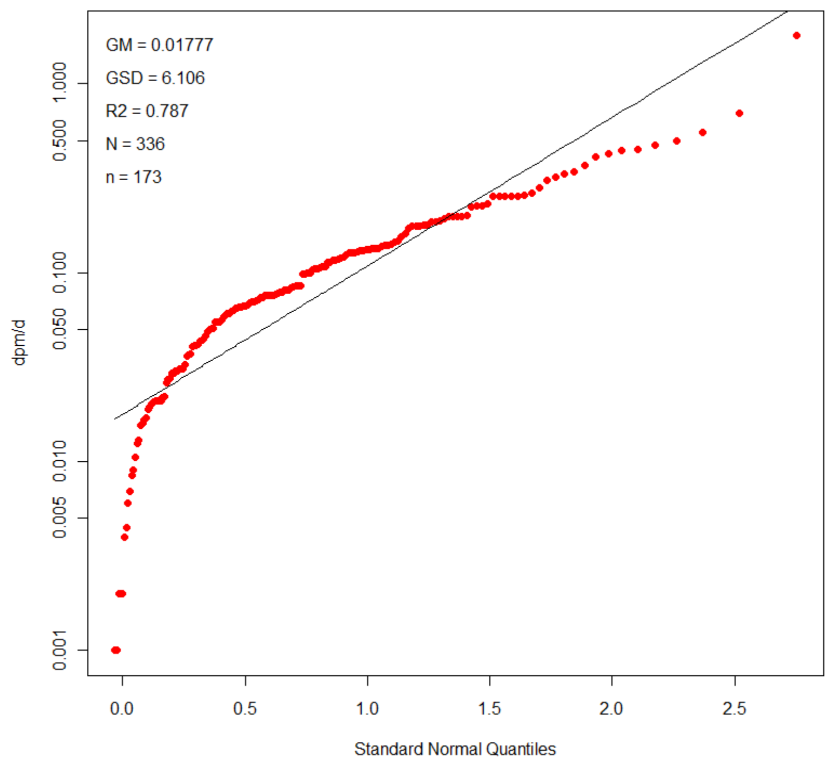

Figure A-90. ROS fit for nonCTWs, 1987 to 1989.

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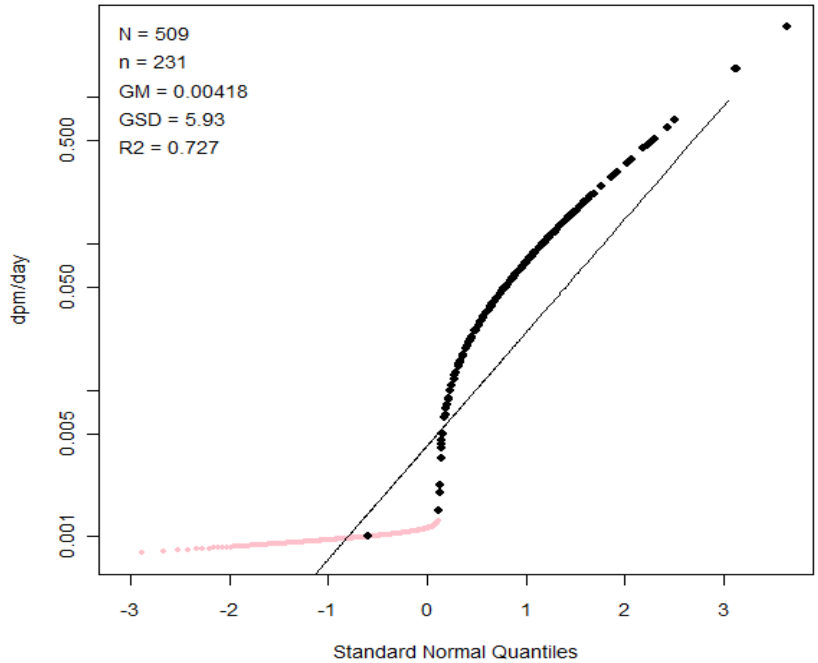

Figure A-91. Effective fit for nonCTWs, 1973.

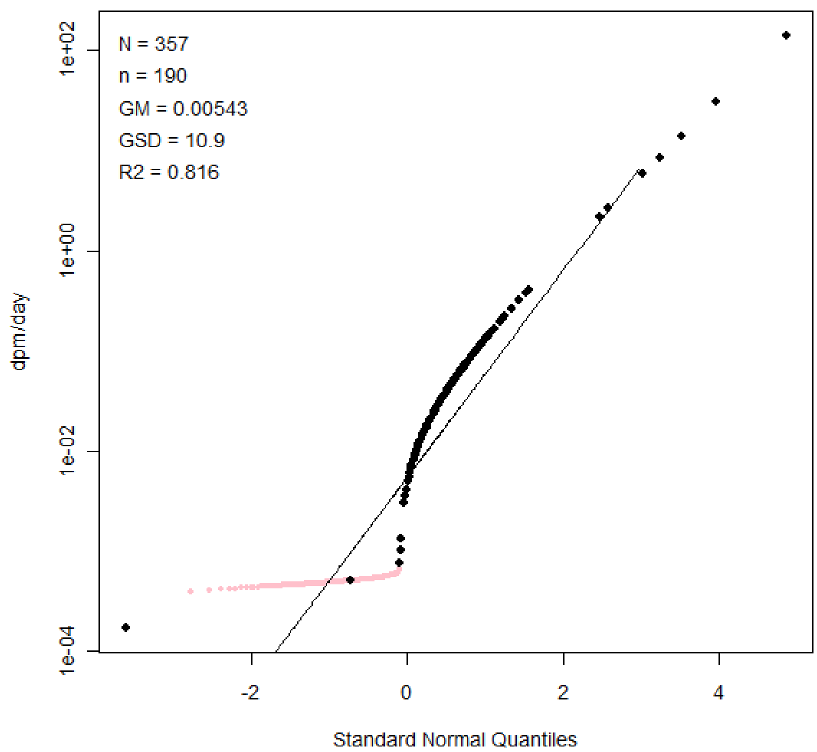

Figure A-92. Effective fit for nonCTWs, 1974.

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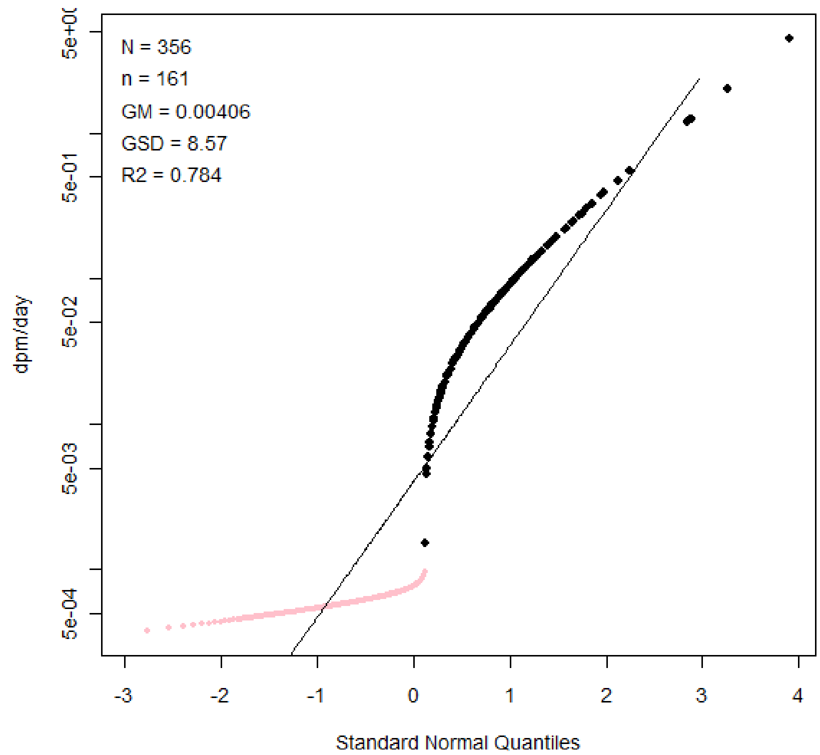

Figure A-93. Effective fit for nonCTWs, 1975.

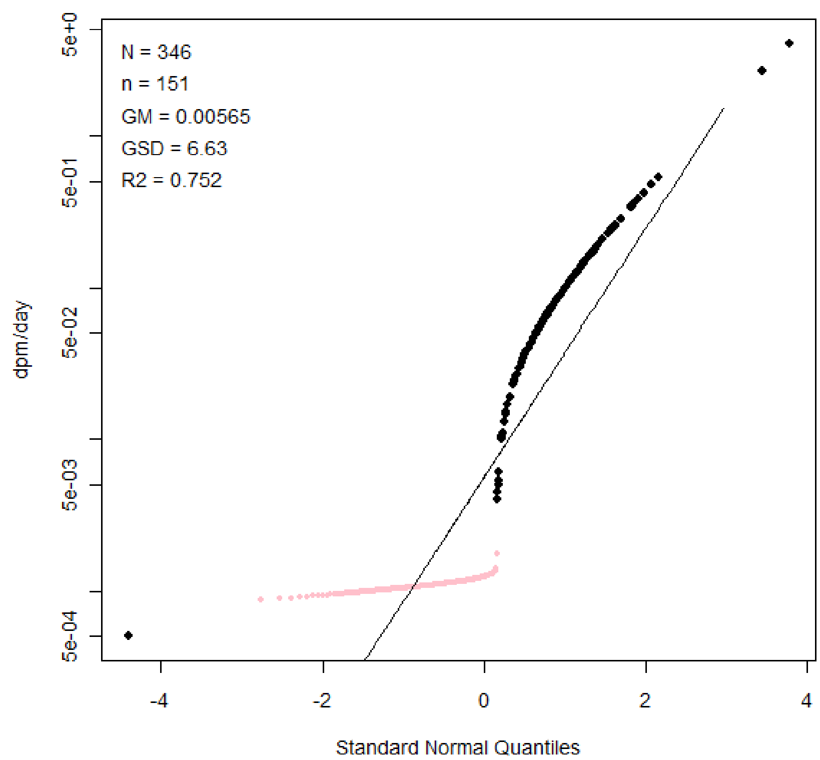

Figure A-94. Effective fit for nonCTWs, 1976.

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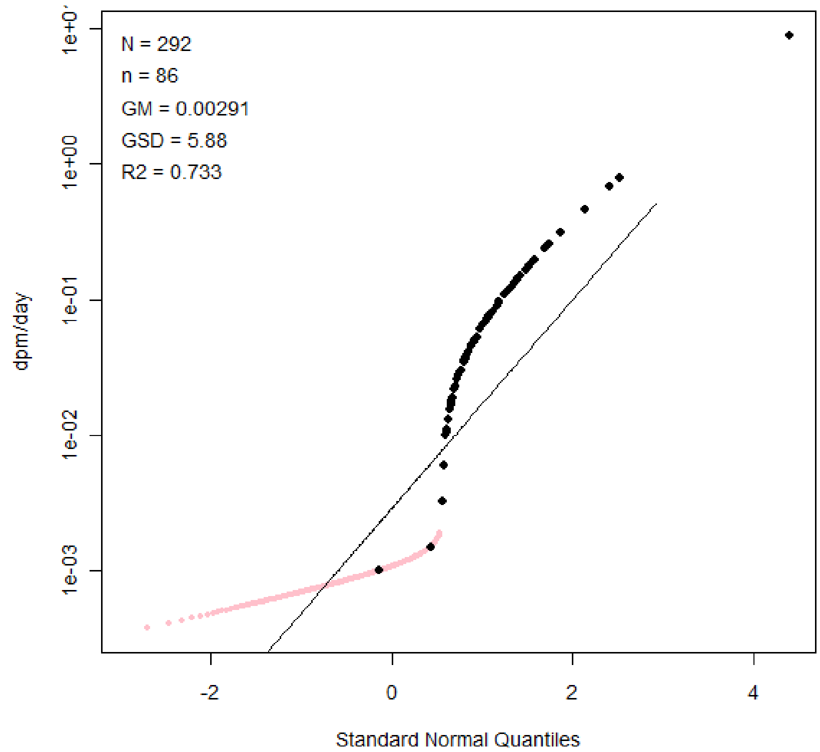

Figure A-95. Effective fit for nonCTWs, 1977.

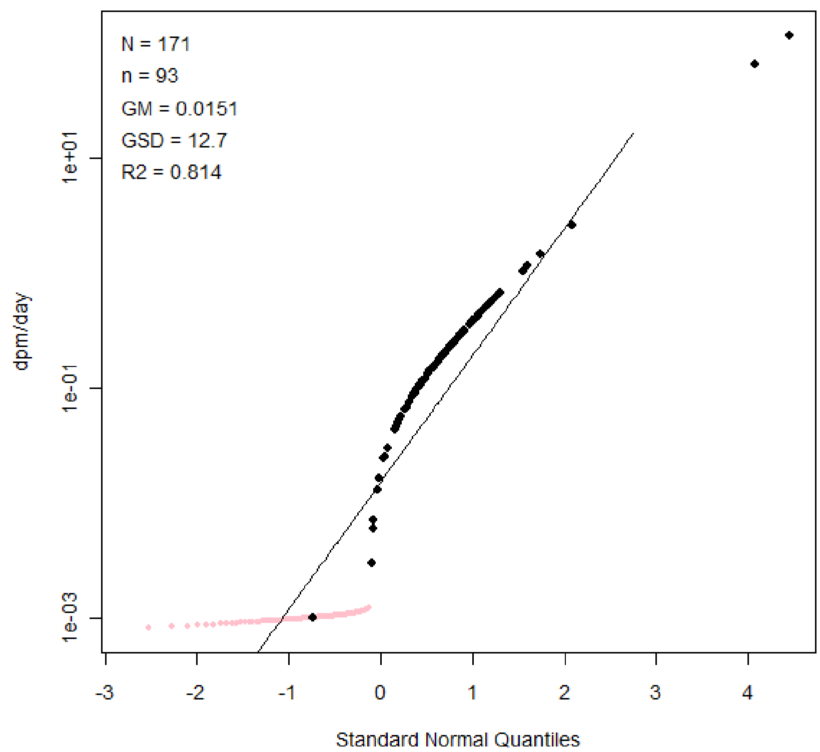

Figure A-96. Effective fit for nonCTWs, 1978.

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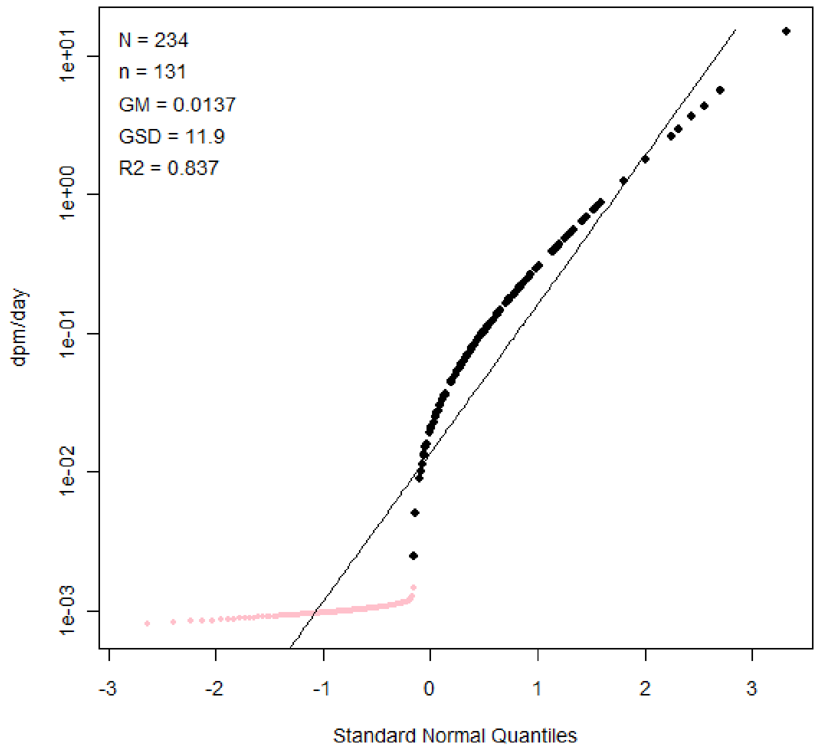

Figure A-97. Effective fit for nonCTWs, 1979.

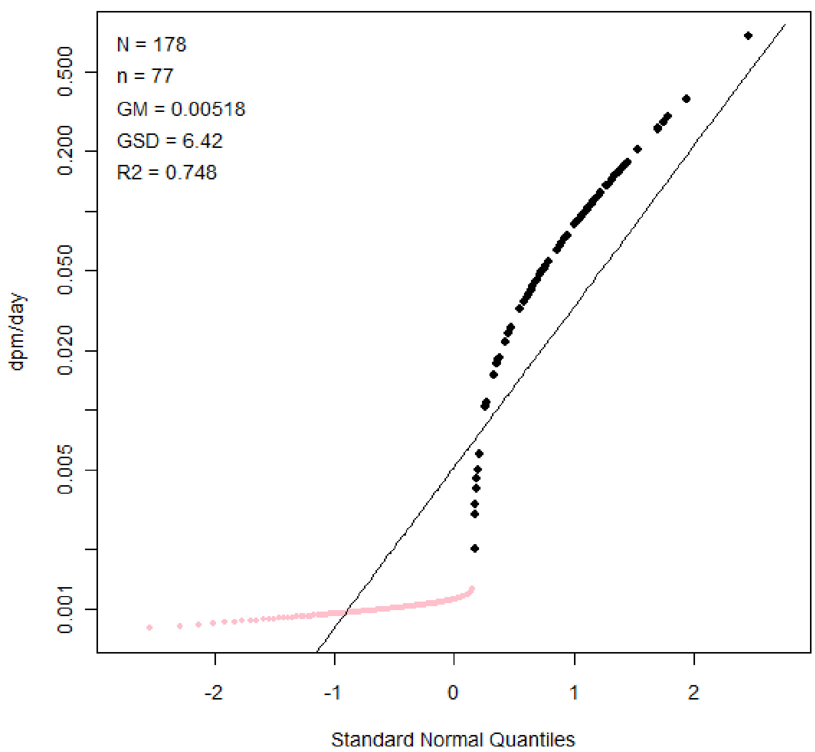

Figure A-98. Effective fit for nonCTWs, 1980.

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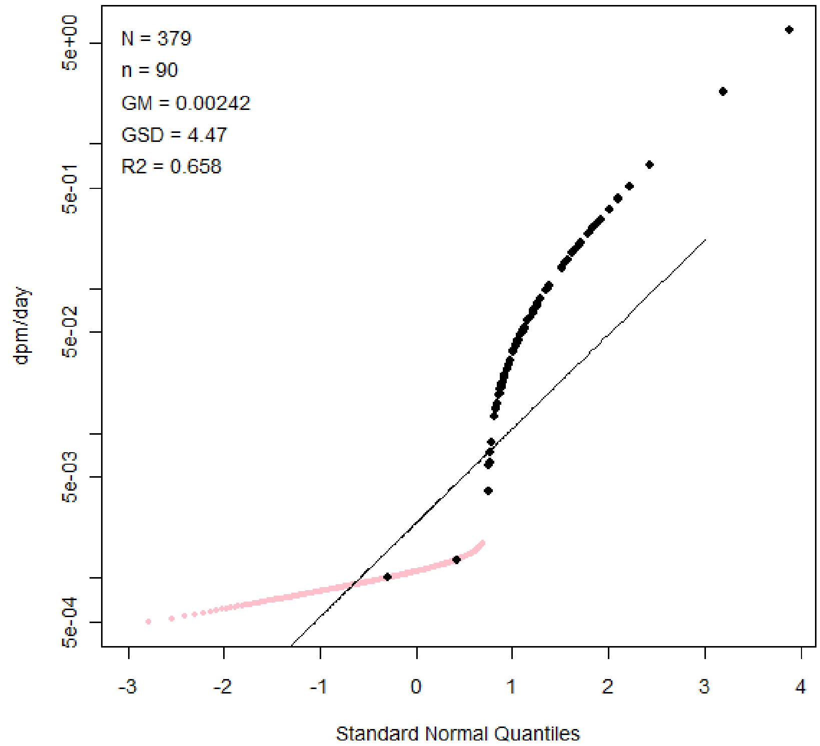

Figure A-99. Effective fit for nonCTWs, 1981 to 1982.

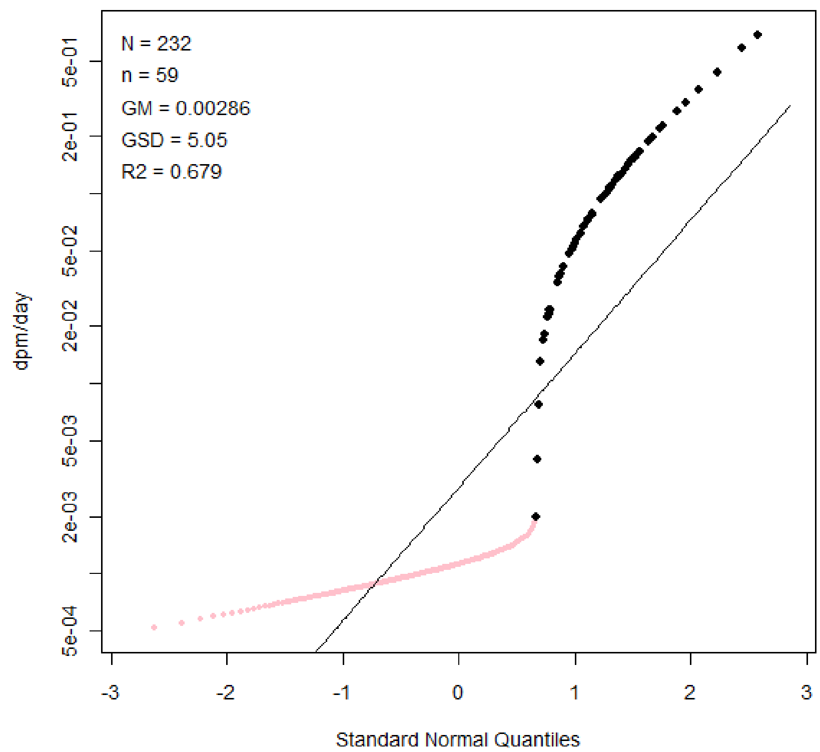

Figure A-100. Effective fit for nonCTWs, 1983.

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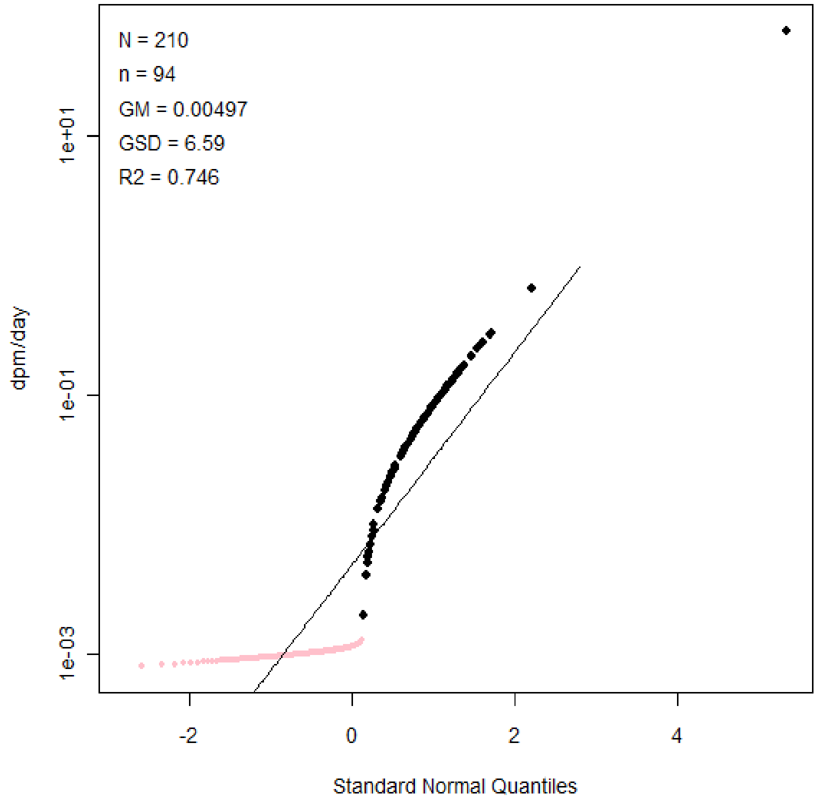

Figure A-101. Effective fit for nonCTWs, 1984.

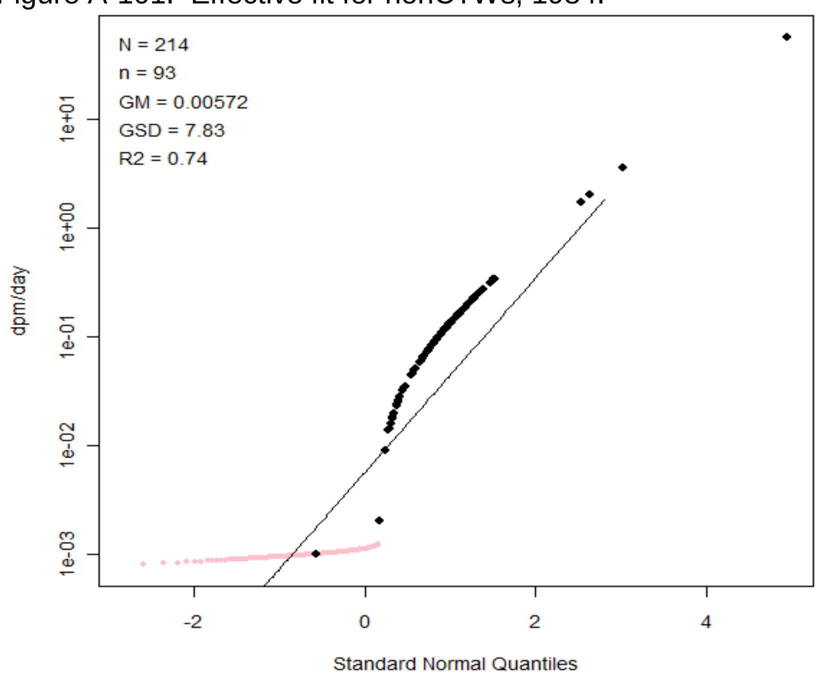

Figure A-102. Effective fit for nonCTWs, 1985.

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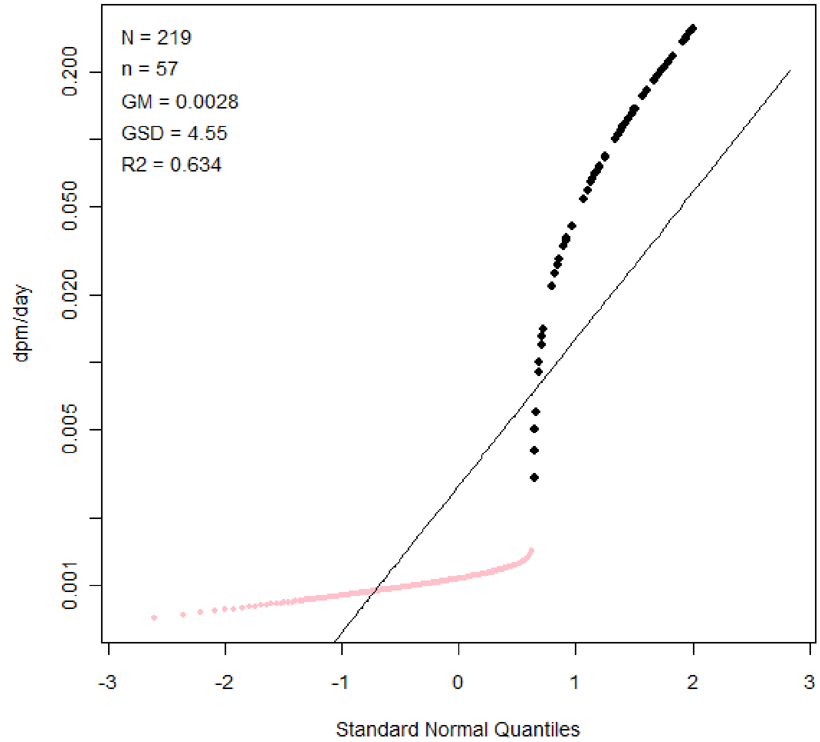

Figure A-103. Effective fit for nonCTWs, 1986.

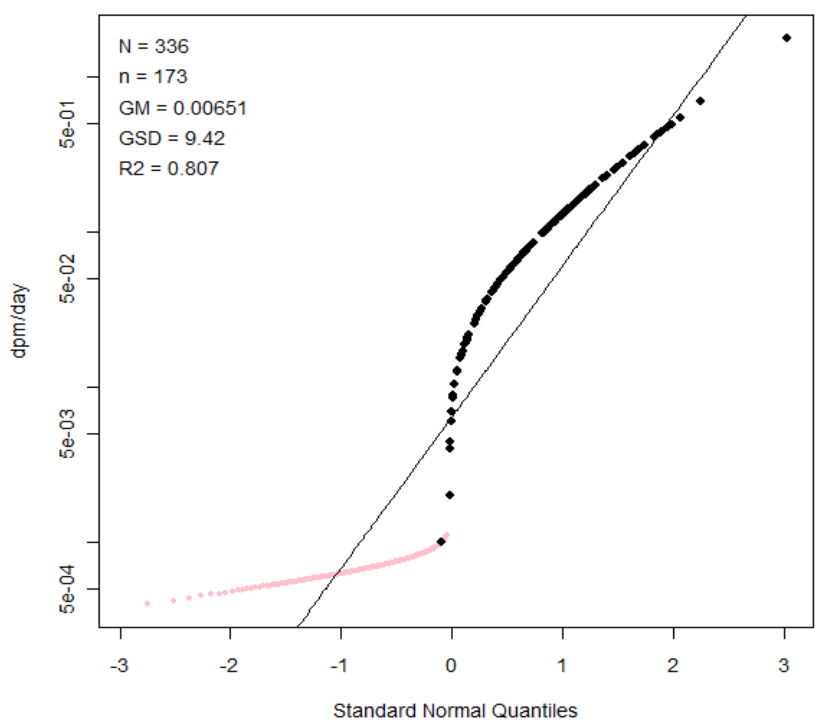

Figure A-104. Effective fit for nonCTWs, 1987 to 1989.

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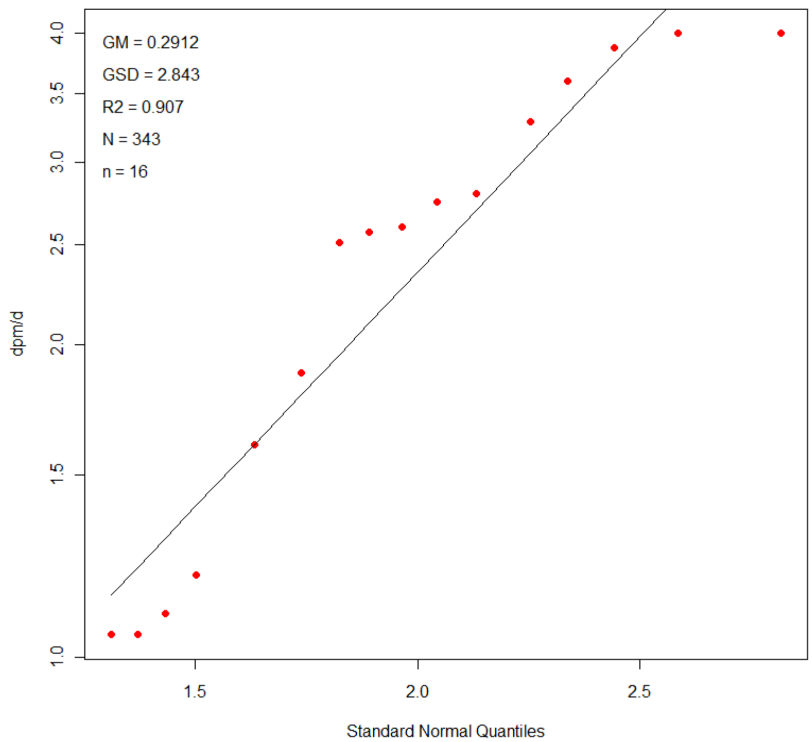

Figure A-105. ROS fit for nonCTWs+unk, 1966 to 1968.

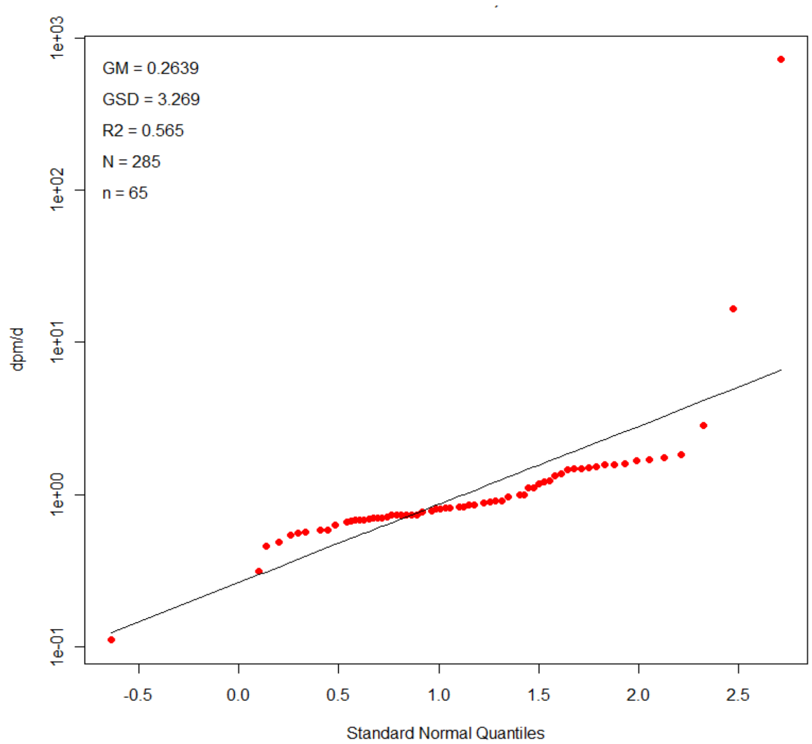

Figure A-106. ROS fit for nonCTWs+unk, 1969.

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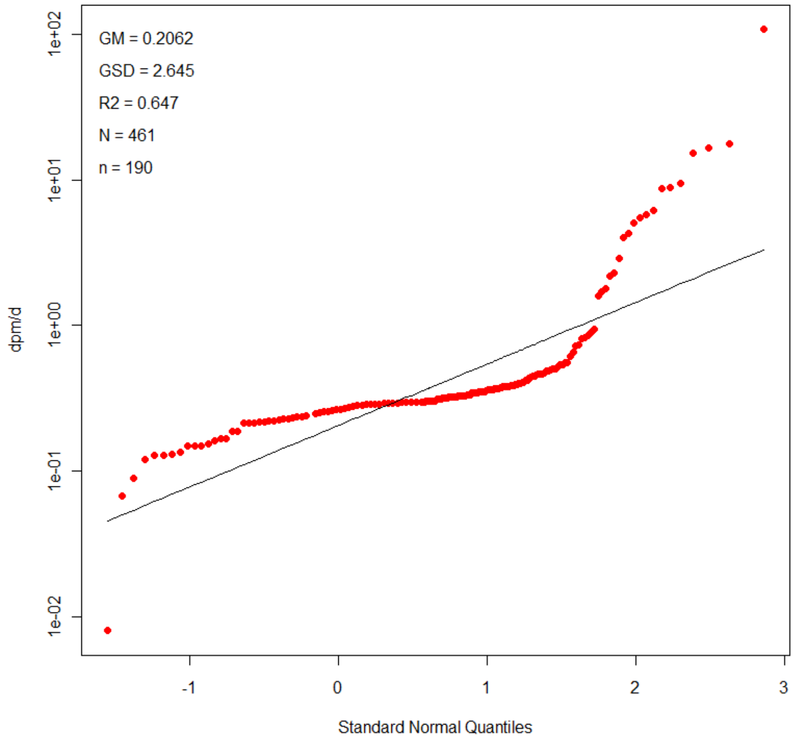

Figure A-107. ROS fit for nonCTWs+unk, 1970.

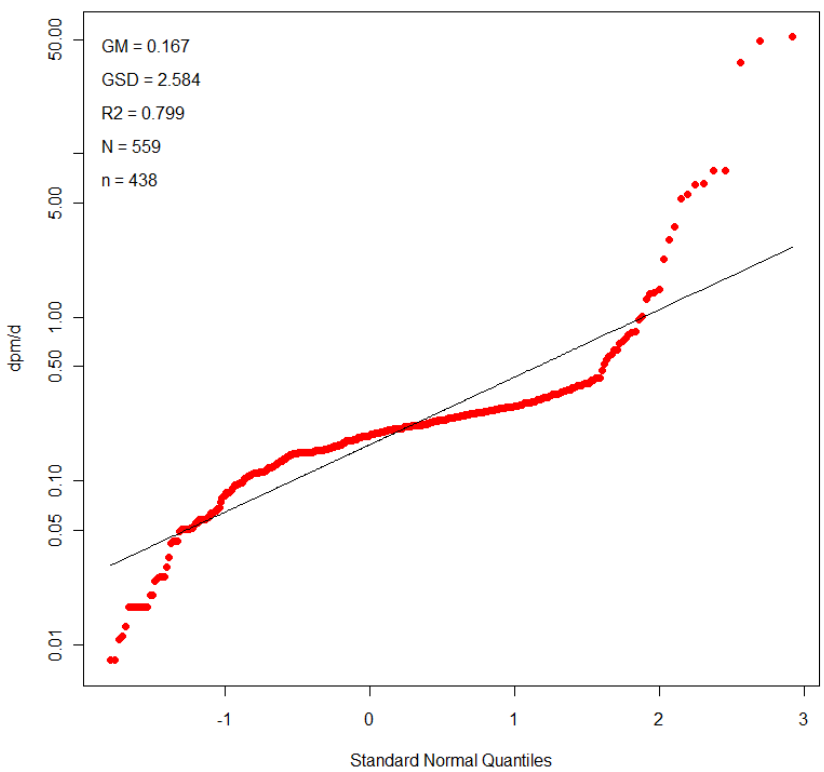

Figure A-108. ROS fit for nonCTWs+unk, 1971.

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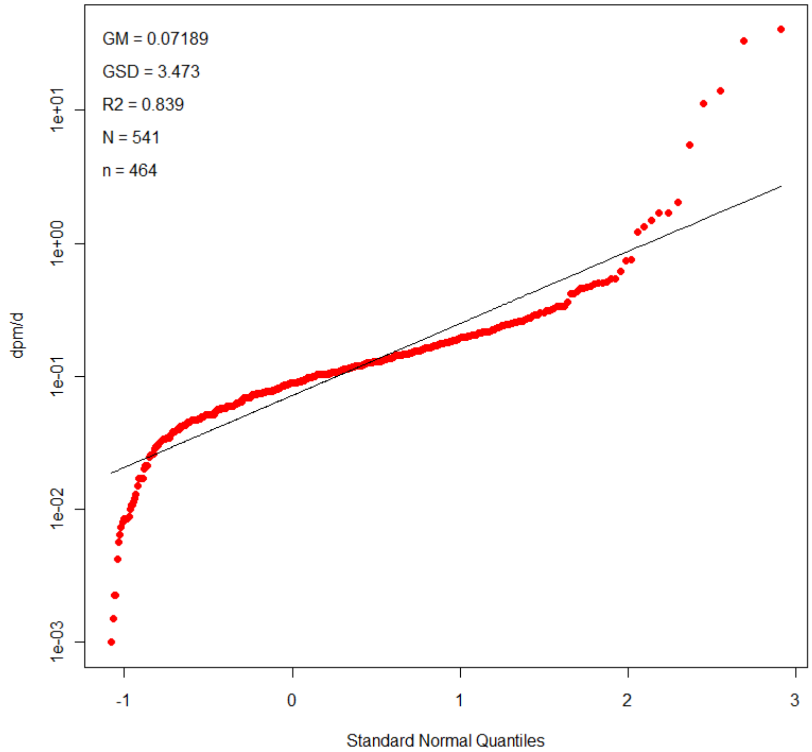

Figure A-109. ROS fit for nonCTWs+unk, 1972.

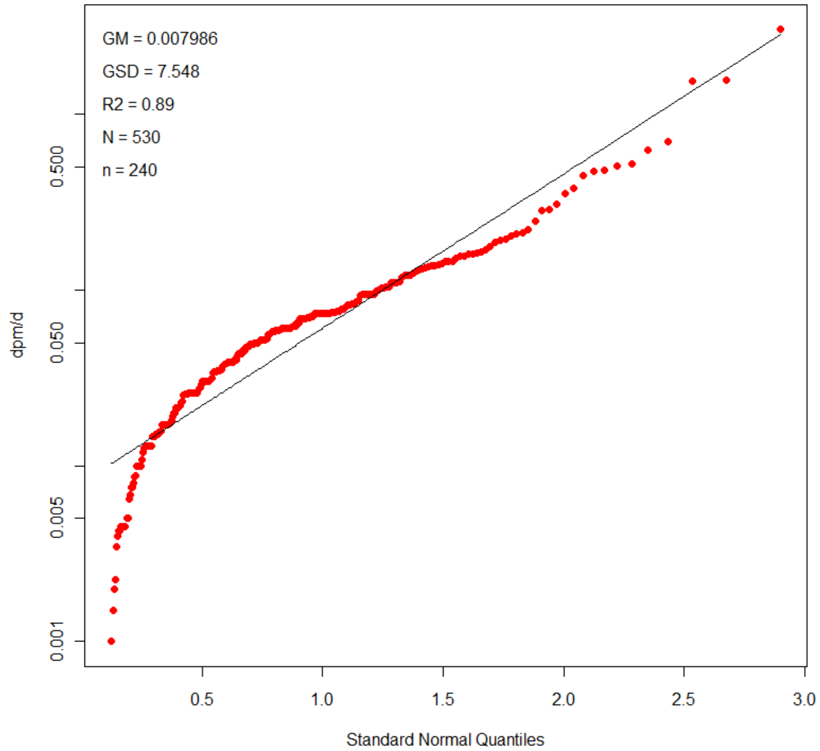

Figure A-110. ROS fit for nonCTWs+unk, 1973.

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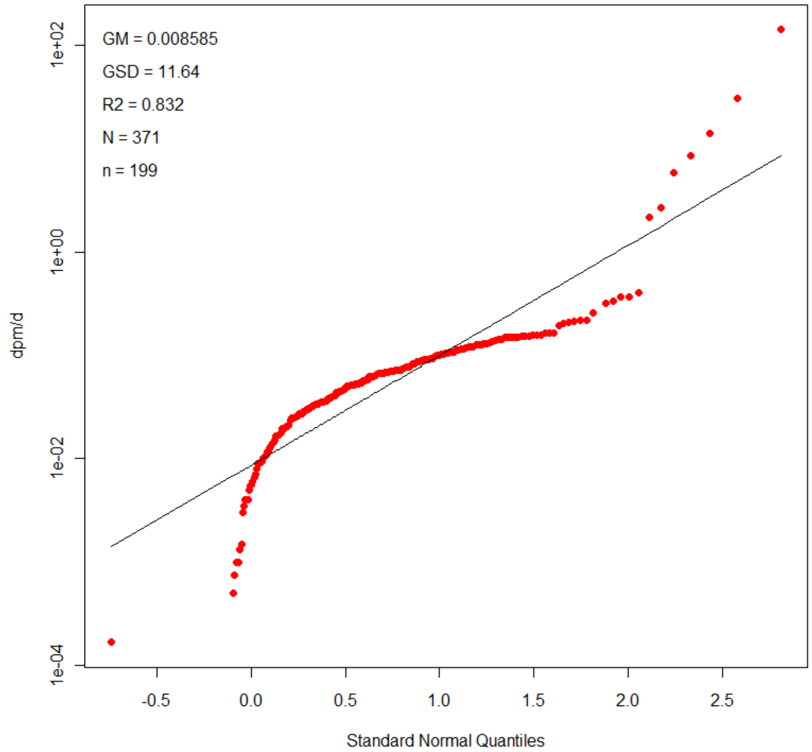

Figure A-111. ROS fit for nonCTWs+unk, 1974.

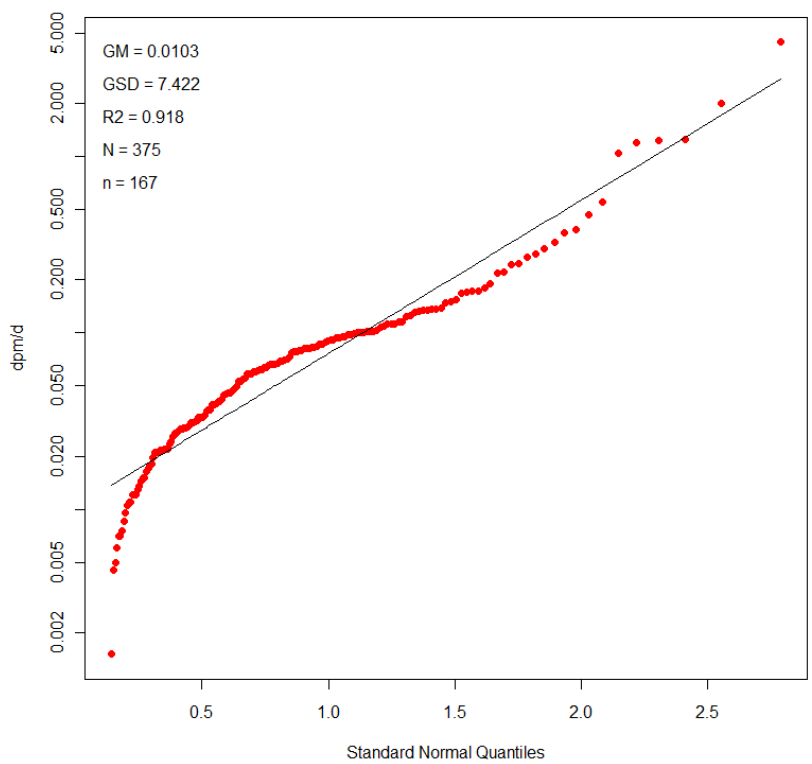

Figure A-112. ROS fit for nonCTWs+unk, 1975.

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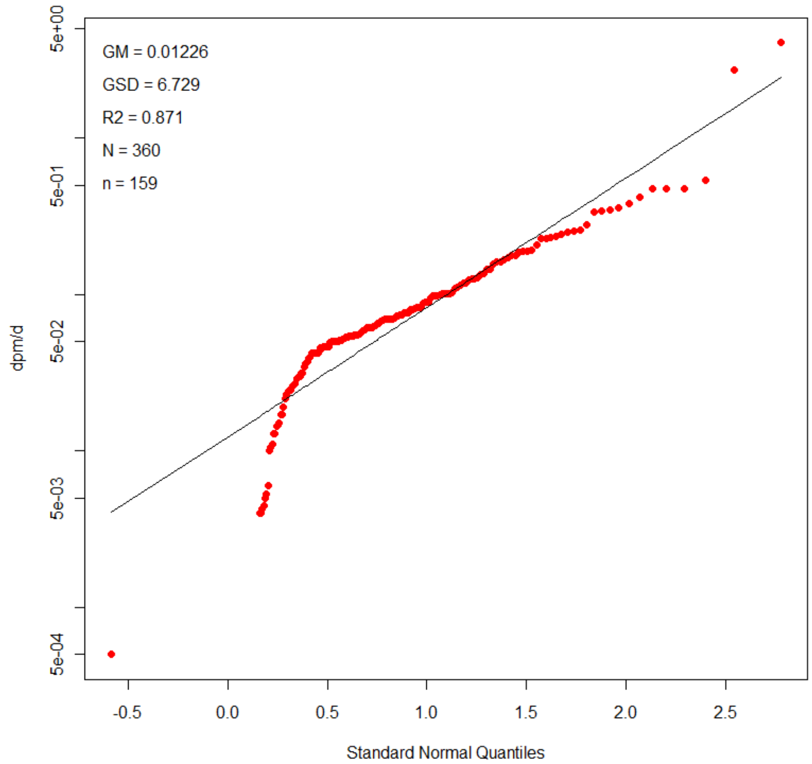

Figure A-113. ROS fit for nonCTWs+unk, 1976.

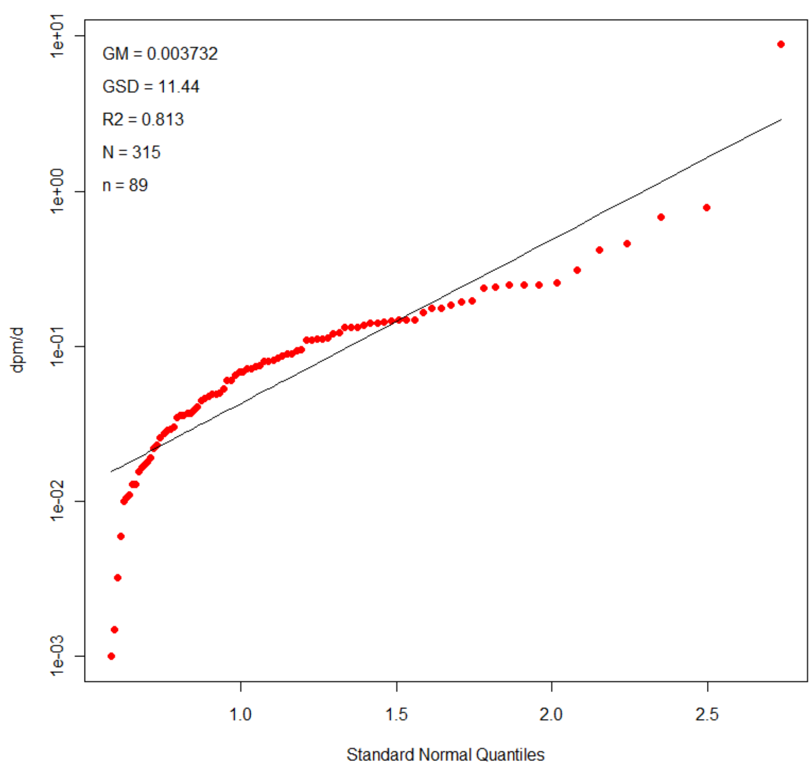

Figure A-114. ROS fit for nonCTWs+unk, 1977.

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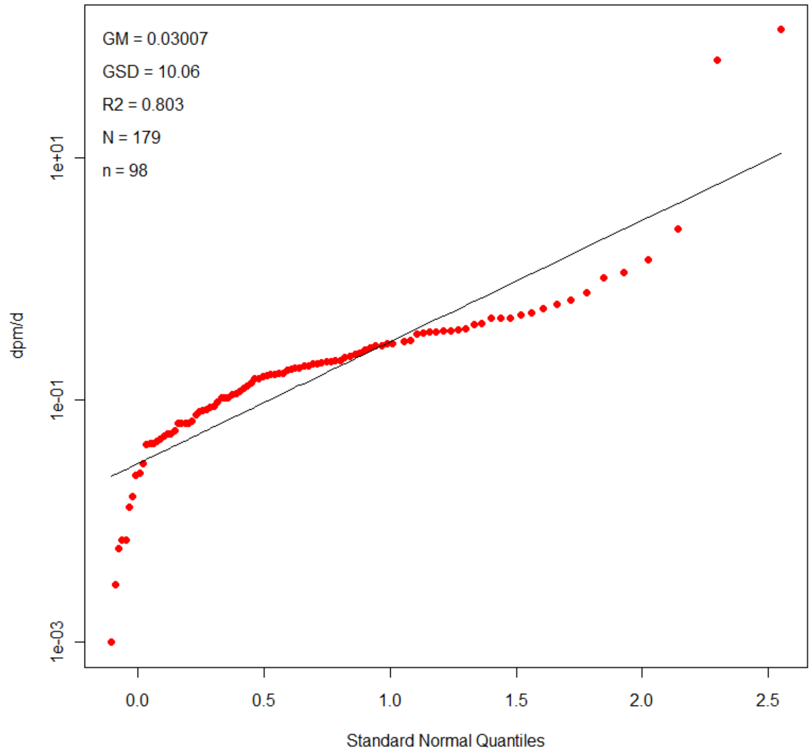

Figure A-115. ROS fit for nonCTWs+unk, 1978.

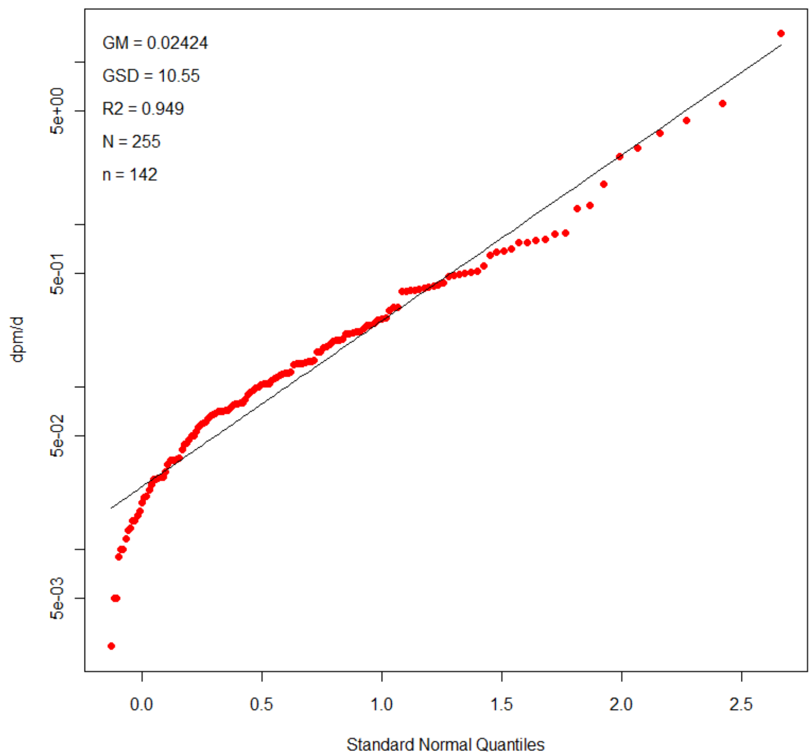

Figure A-116. ROS fit for nonCTWs+unk, 1979.

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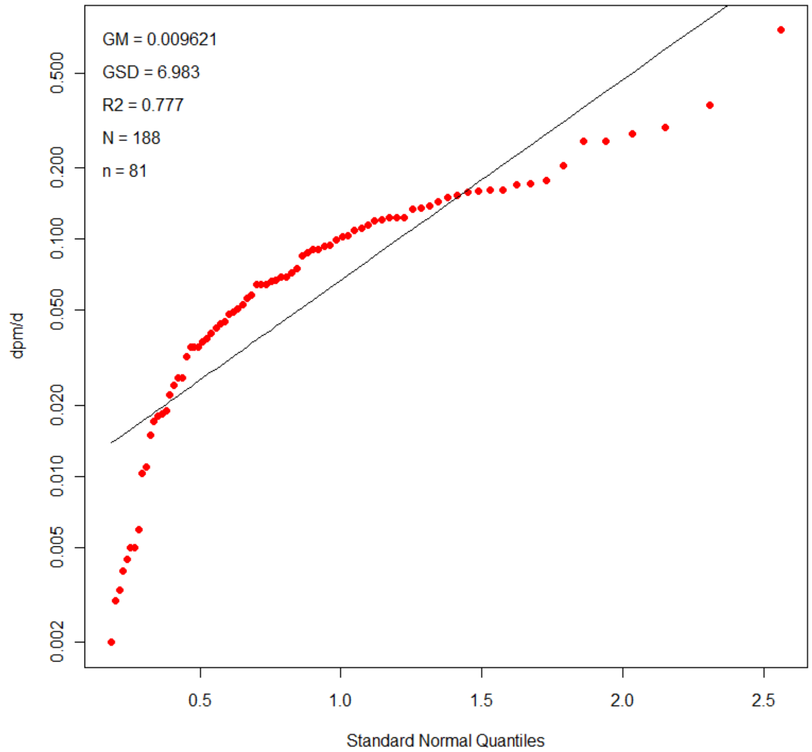

Figure A-117. ROS fit for nonCTWs+unk, 1980.

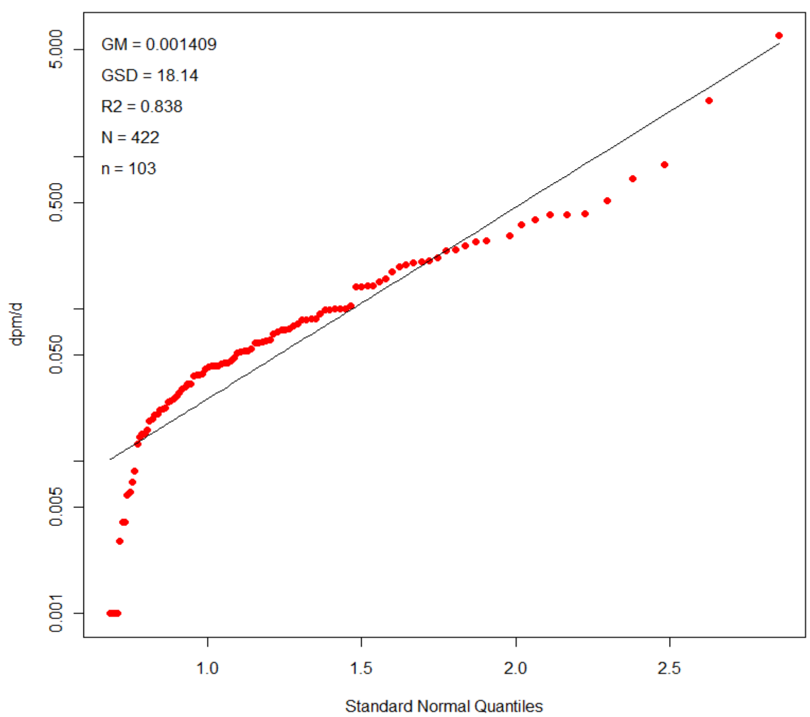

Figure A-118. ROS fit for nonCTWs+unk, 1981 to 1982.

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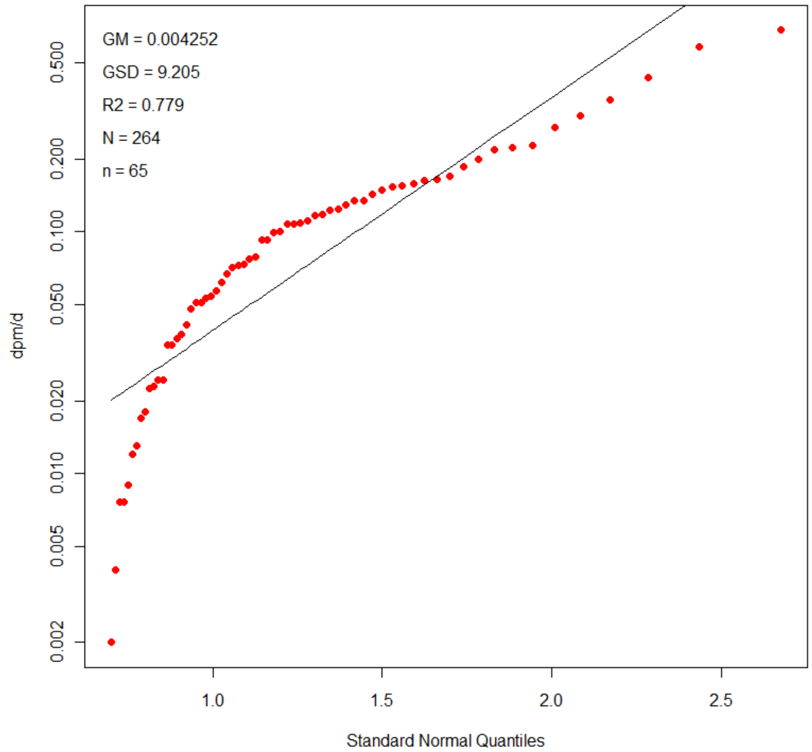

Figure A-119. ROS fit for nonCTWs+unk, 1983.

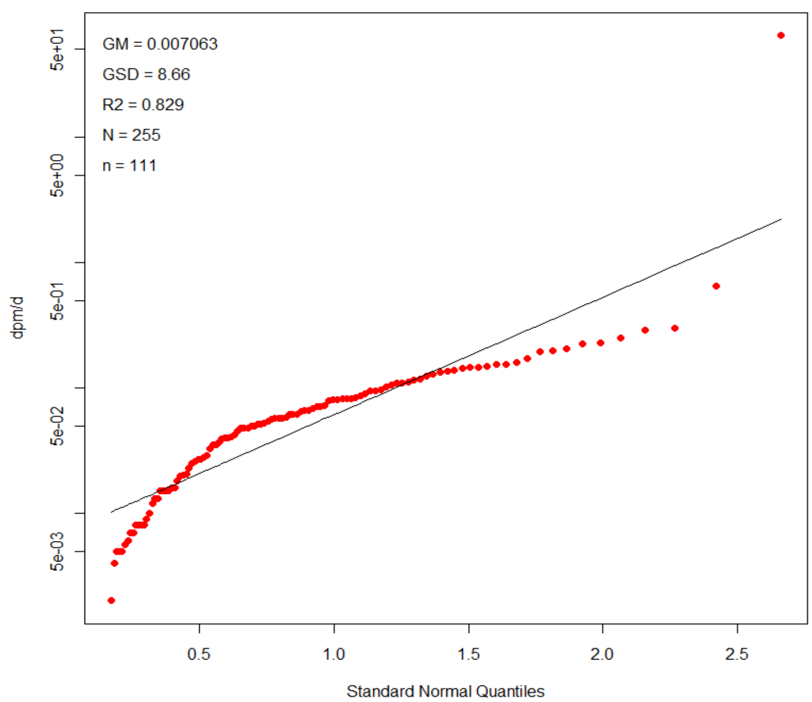

Figure A-120. ROS fit for nonCTWs+unk, 1984.

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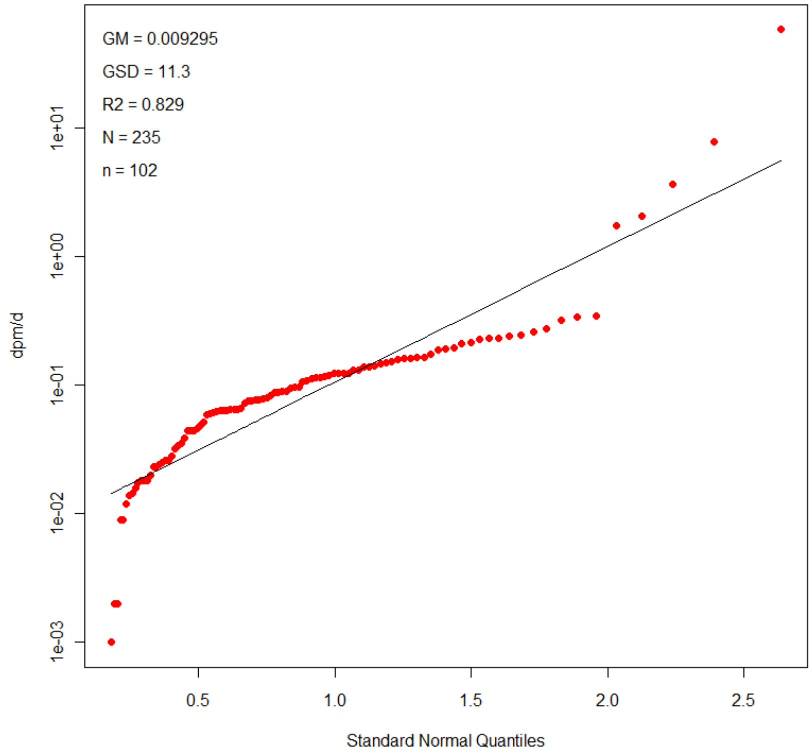

Figure A-121. ROS fit for nonCTWs+unk, 1985.

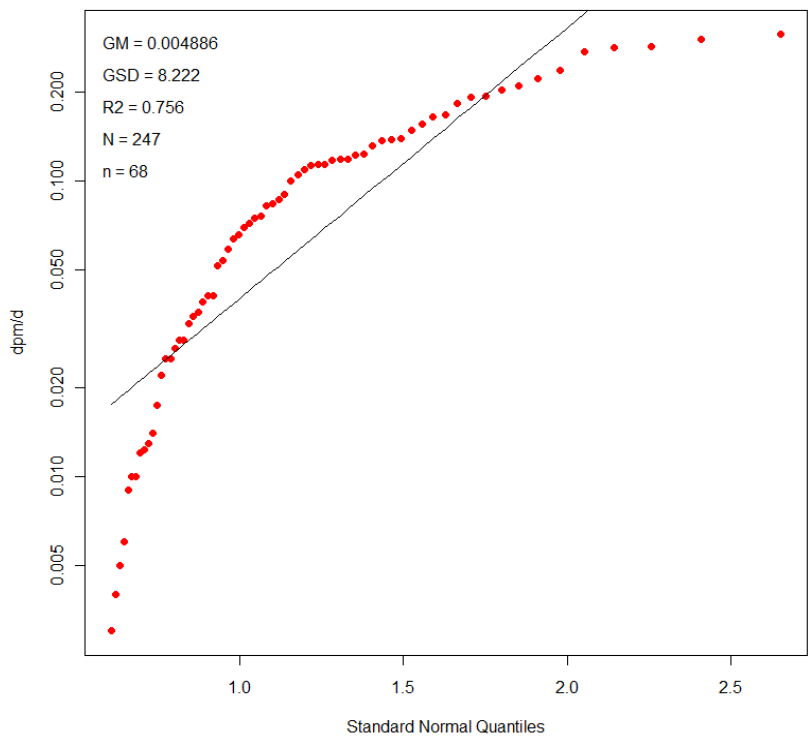

Figure A-122. ROS fit for nonCTWs+unk, 1986.

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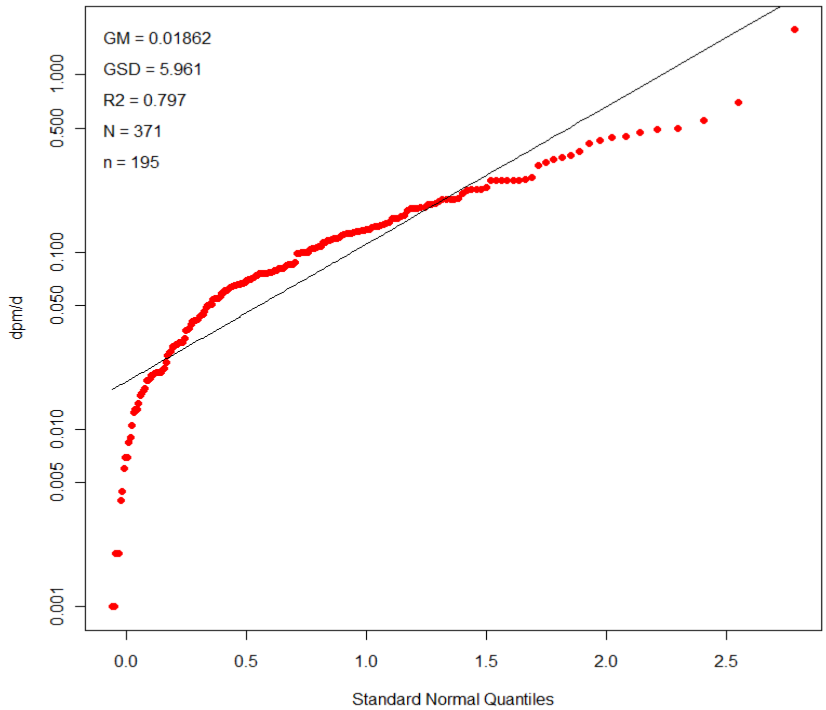

Figure A-123. ROS fit for nonCTWs+unk, 1987 to 1989.

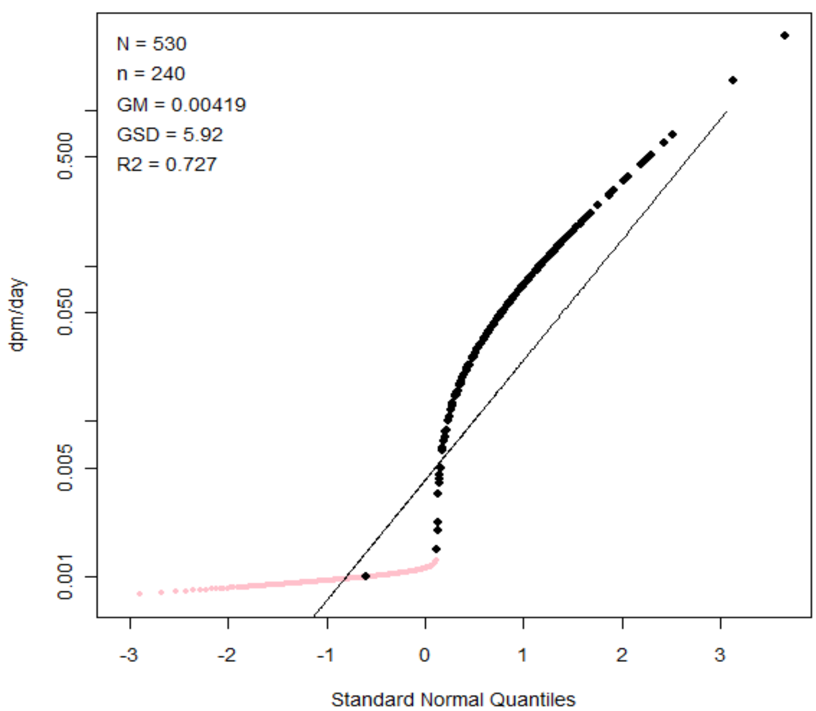

Figure A-124. Effective fit for nonCTWs+unk, 1973.

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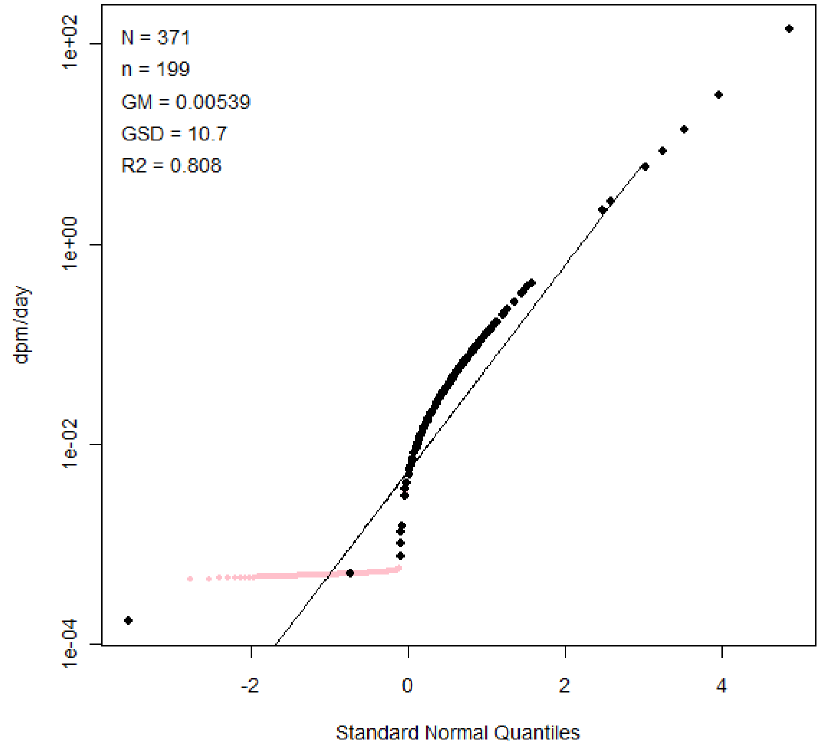

Figure A-125. Effective fit for nonCTWs+unk, 1974.

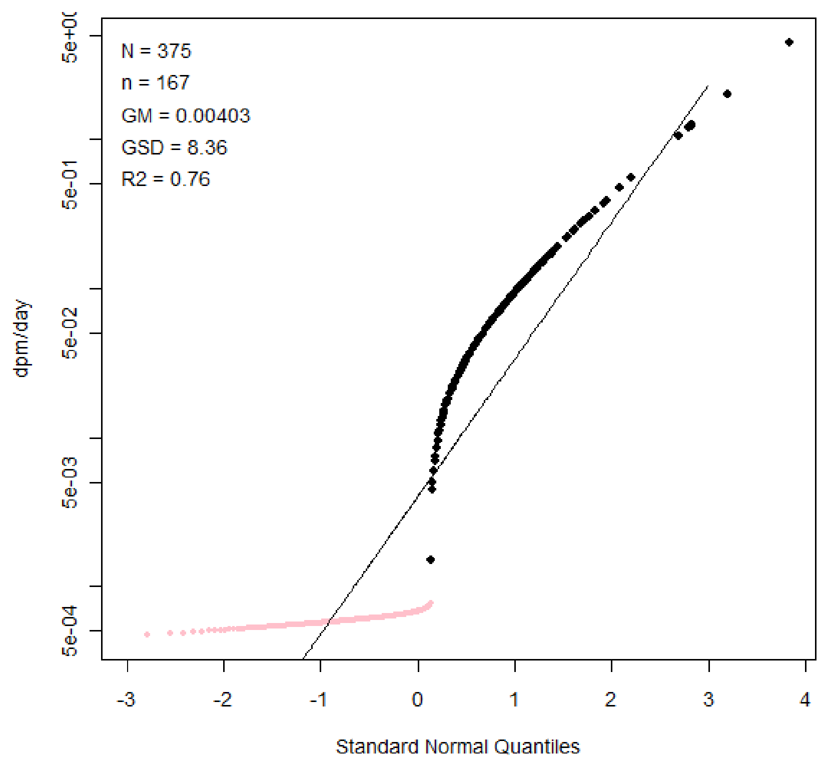

Figure A-126. Effective fit for nonCTWs+unk, 1975.

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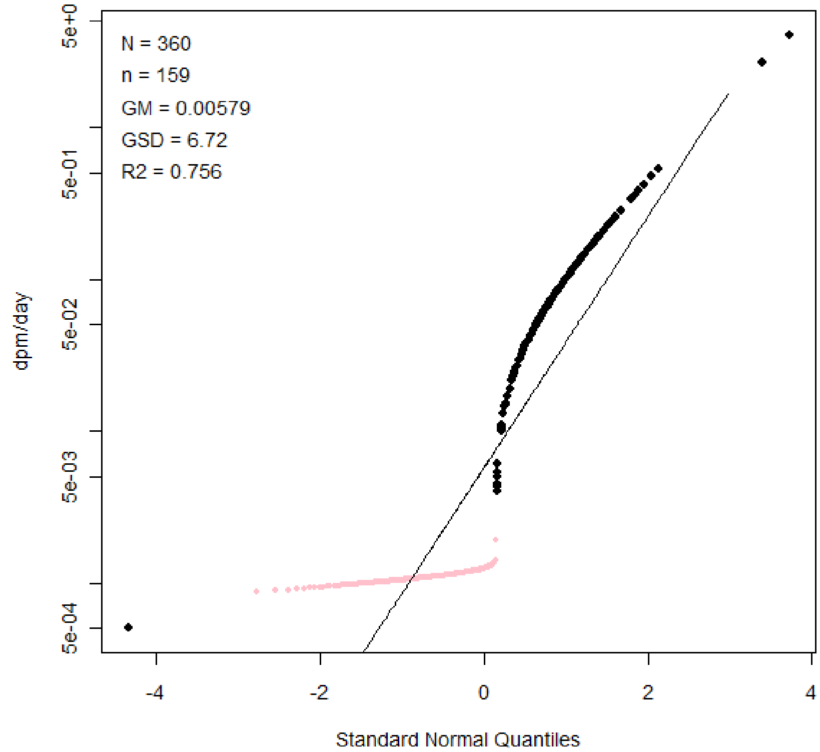

Figure A-127. Effective fit for nonCTWs+unk, 1976.

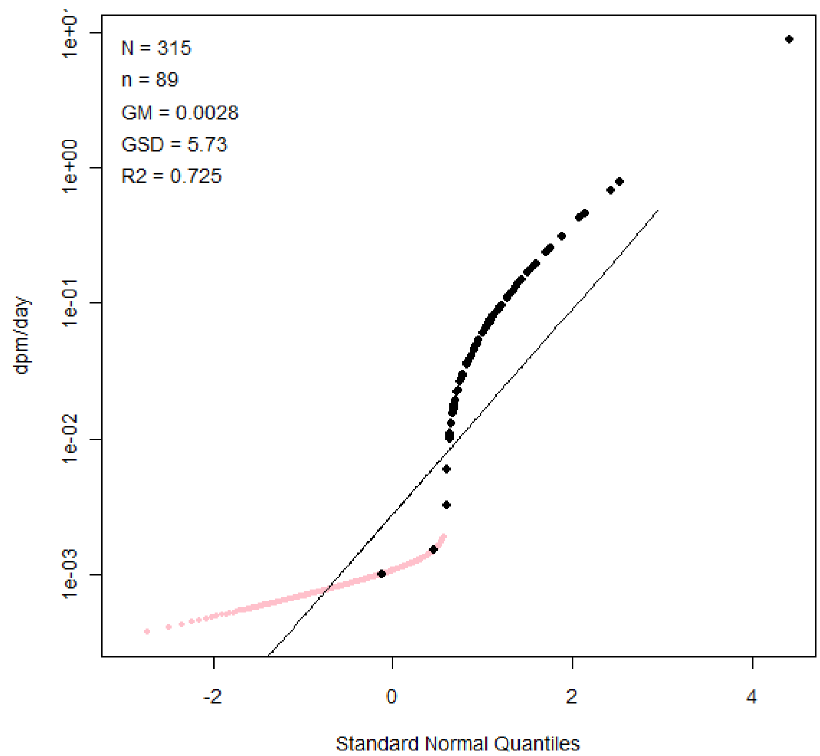

Figure A-128. Effective fit for nonCTWs+unk, 1977.

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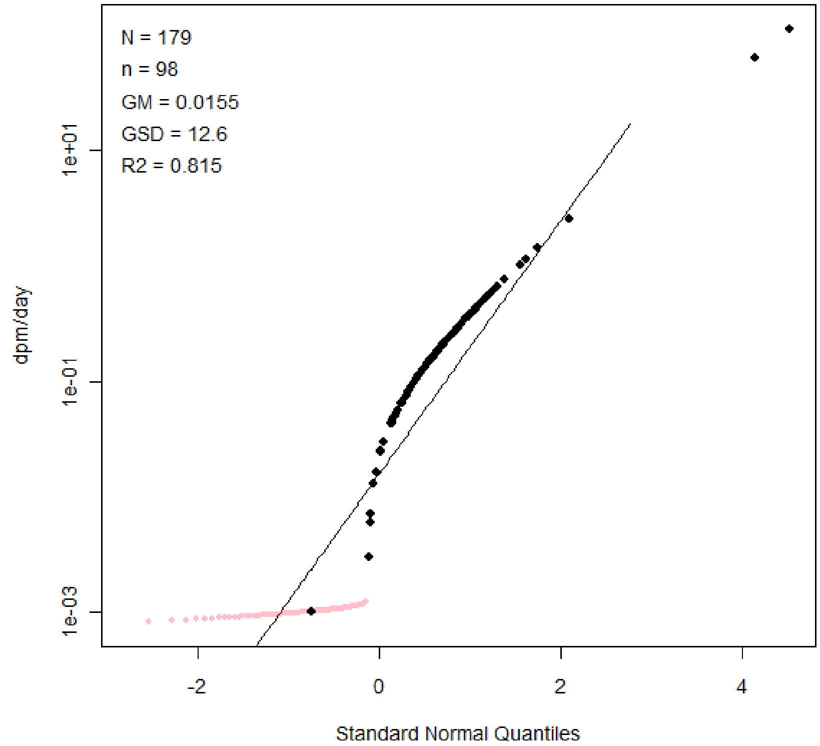

Figure A-129. Effective fit for nonCTWs+unk, 1978.

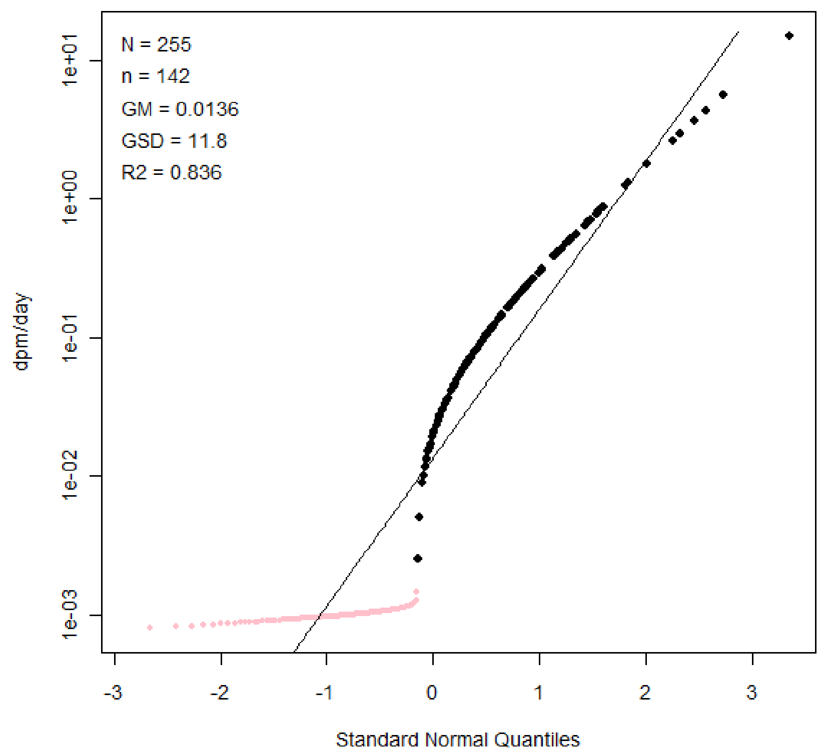

Figure A-130. Effective fit for nonCTWs+unk, 1979.

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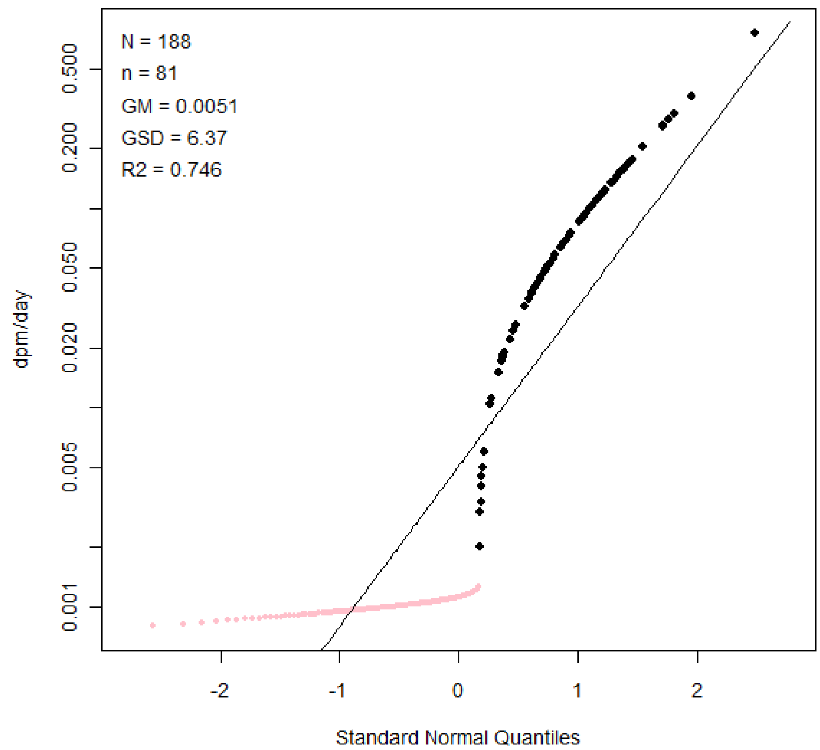

Figure A-131. Effective fit for nonCTWs+unk, 1980.

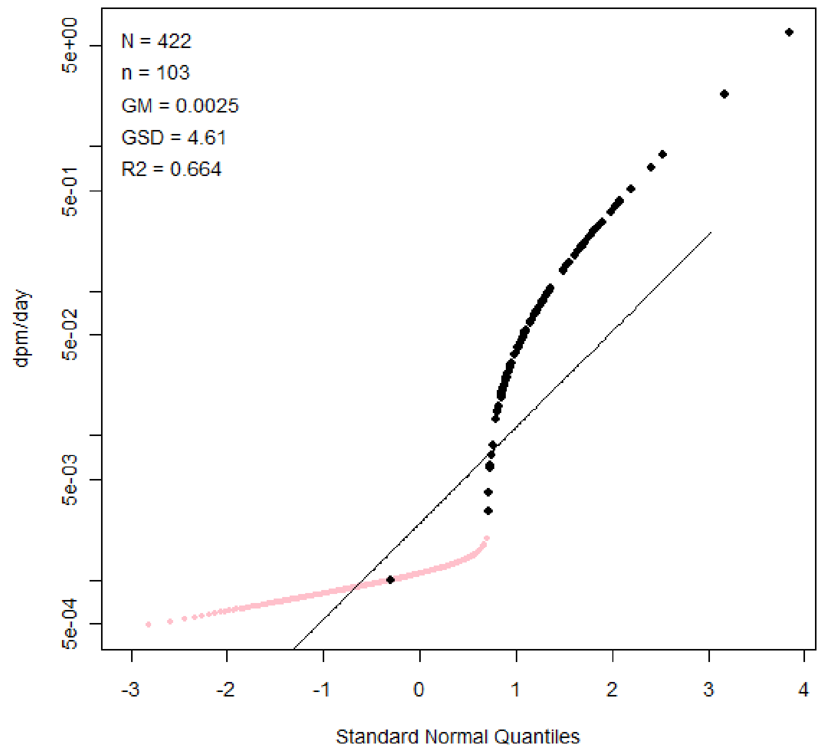

Figure A-132. Effective fit for nonCTWs+unk, 1981 to 1982.

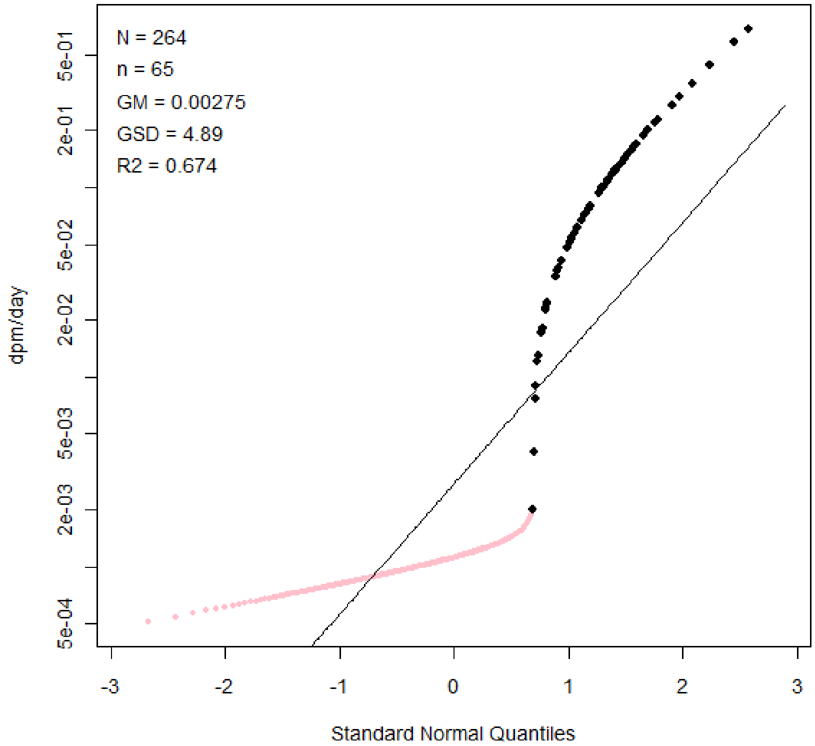

Figure A-133. Effective fit for nonCTWs+unk, 1983.

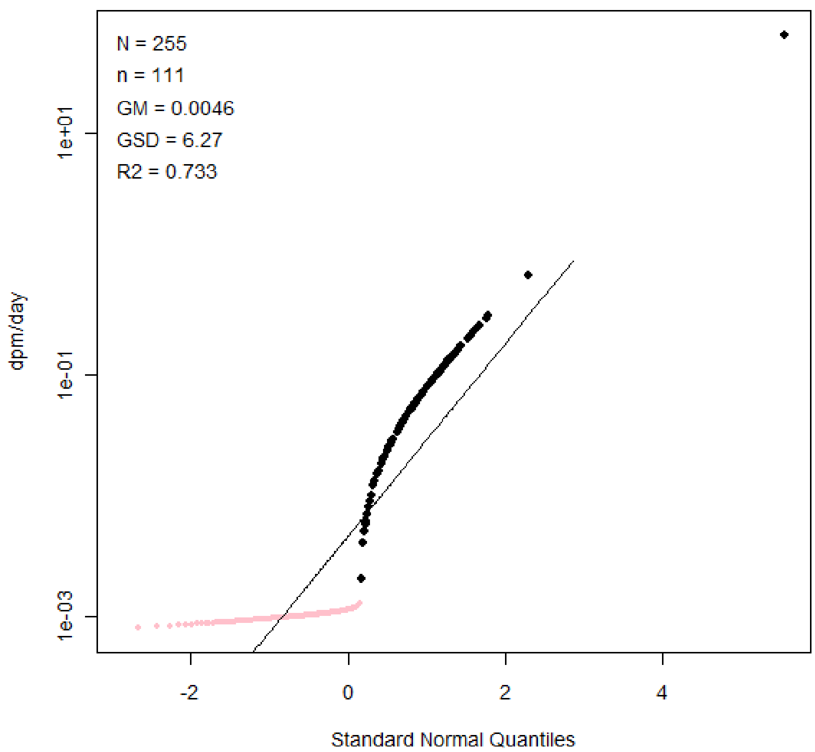

Figure A-134. Effective fit for nonCTWs+unk, 1984.

ATTACHMENT A
ROS AND EFFECTIVE FIT PLOTS FOR AMWS, CTW, NONCTWS, AND NONCTW+UNKS

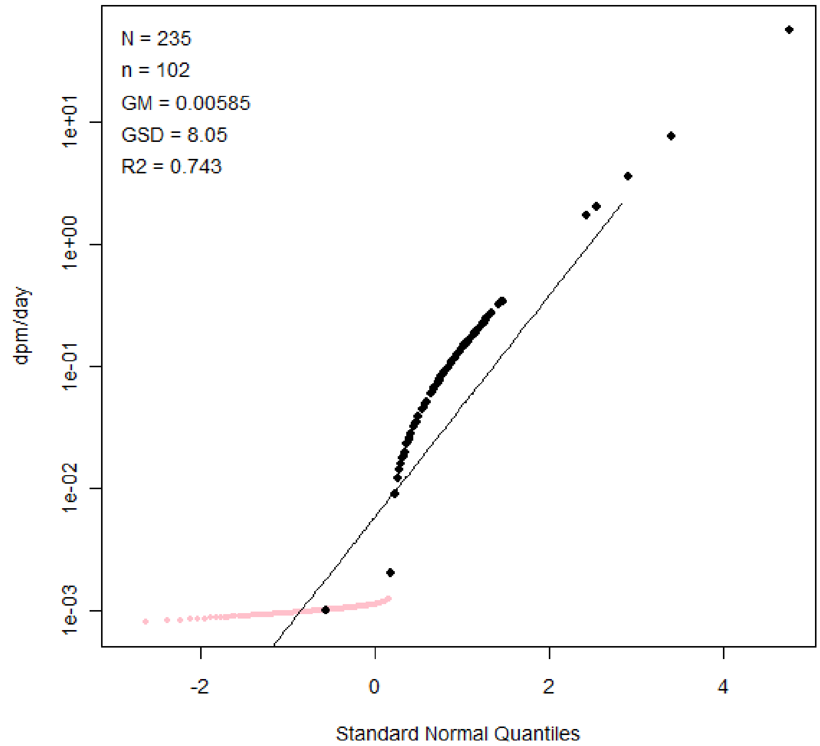

Figure A-135. Effective fit for nonCTWs+unk, 1985.

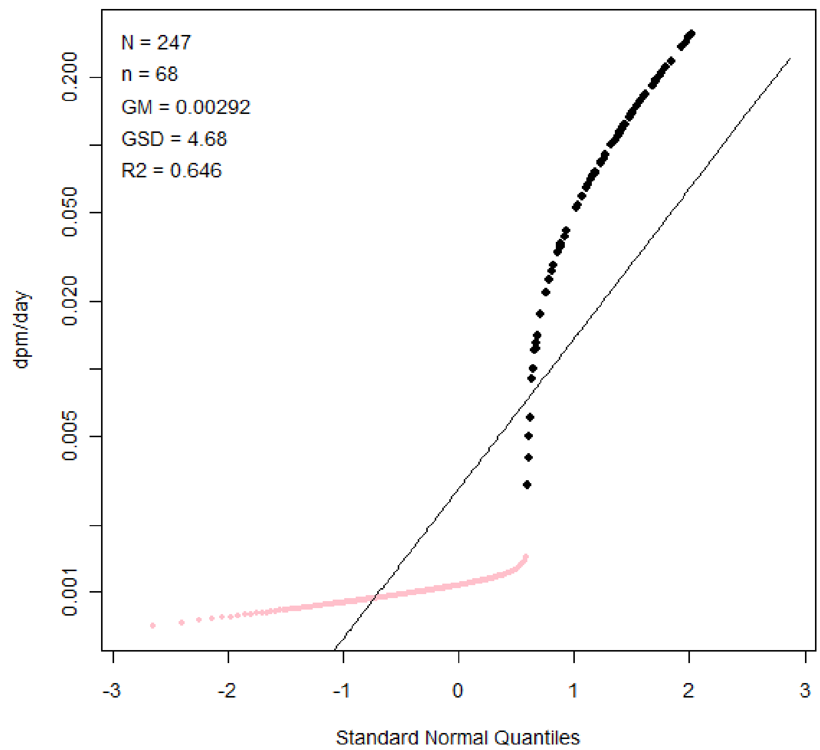

Figure A-136. Effective fit for nonCTWs+unk, 1986.

ATTACHMENT A
ROS AND EFFECTIVE FIT PLOTS FOR AMWS, CTW, NONCTWS, AND NONCTW+UNKS

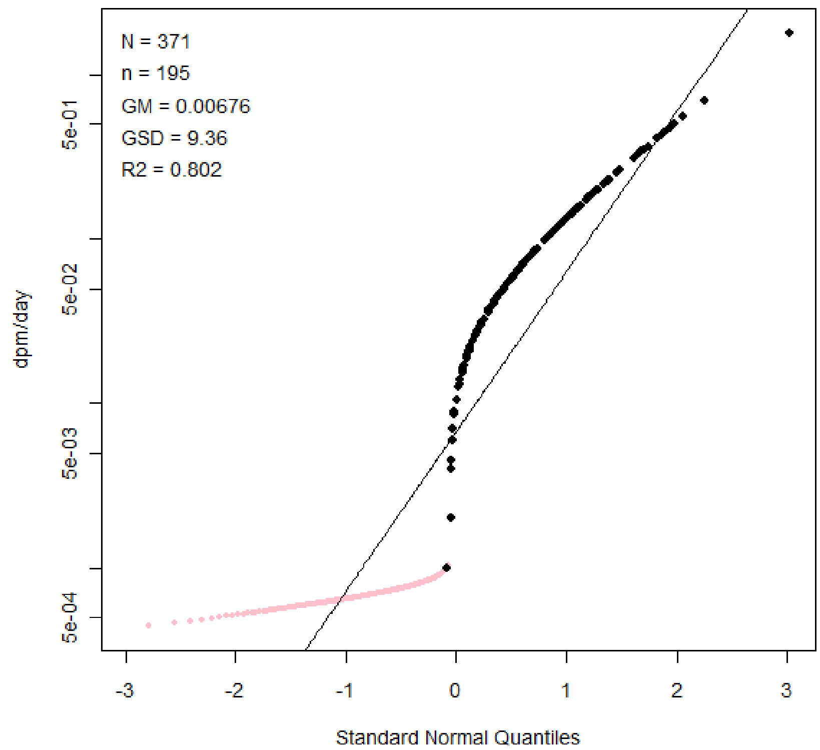

Figure A-137. Effective fit for nonCTWs+unk, 1987 to 1989.

ATTACHMENT B
PETO-PRENTICE PLOTS FOR CTW:NONCTW AND CTW:NONCTW+UNK COMPARISONS
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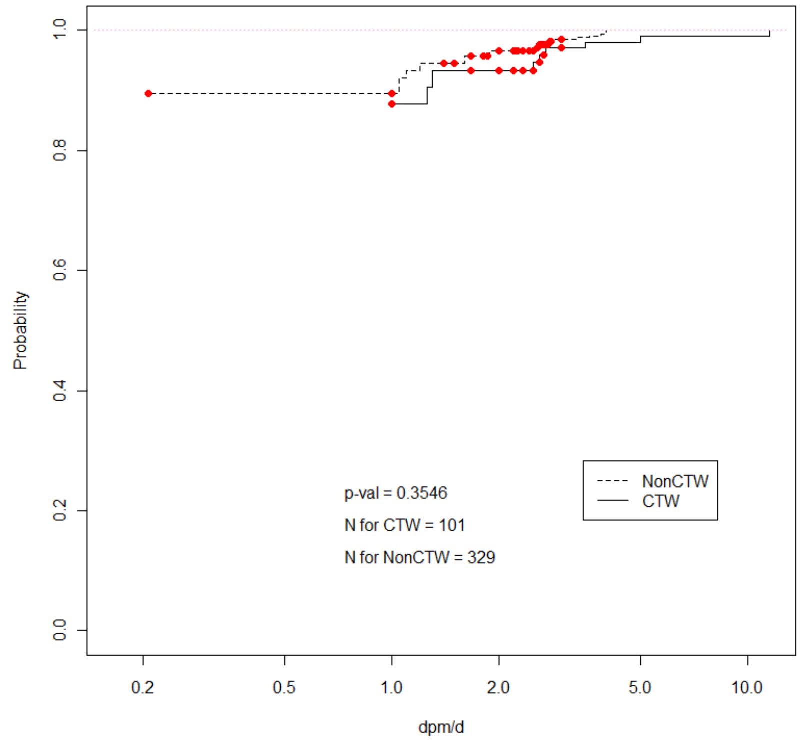

Figure B-1. Peto-Prentice test for CTW:nonCTW, 1966 to 1968.

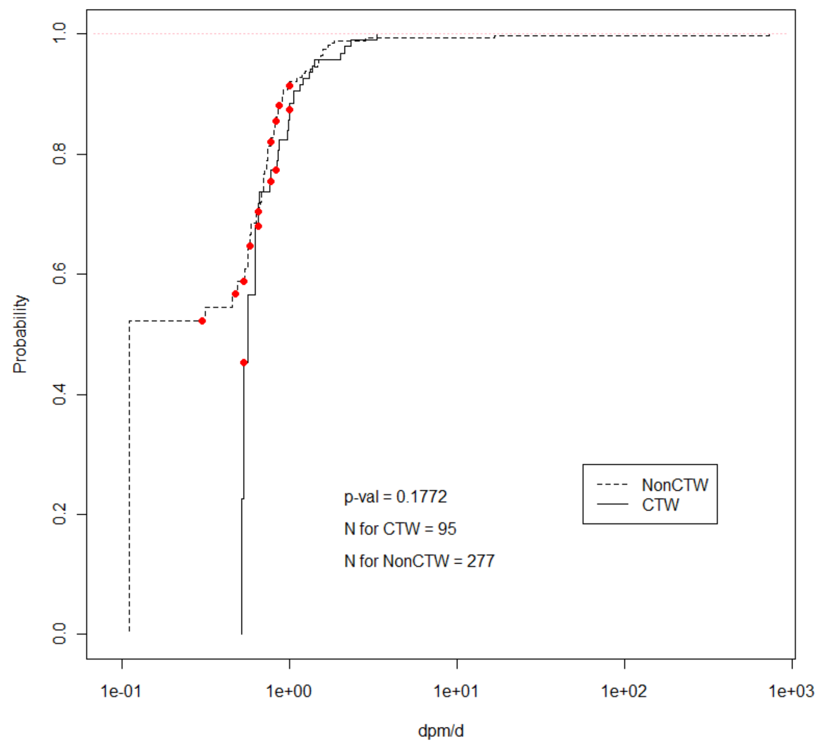

Figure B-2. Peto-Prentice test for CTW:nonCTW, 1969.

ATTACHMENT B
PETO-PRENTICE PLOTS FOR CTW:NONCTW AND CTW:NONCTW+UNK COMPARISONS

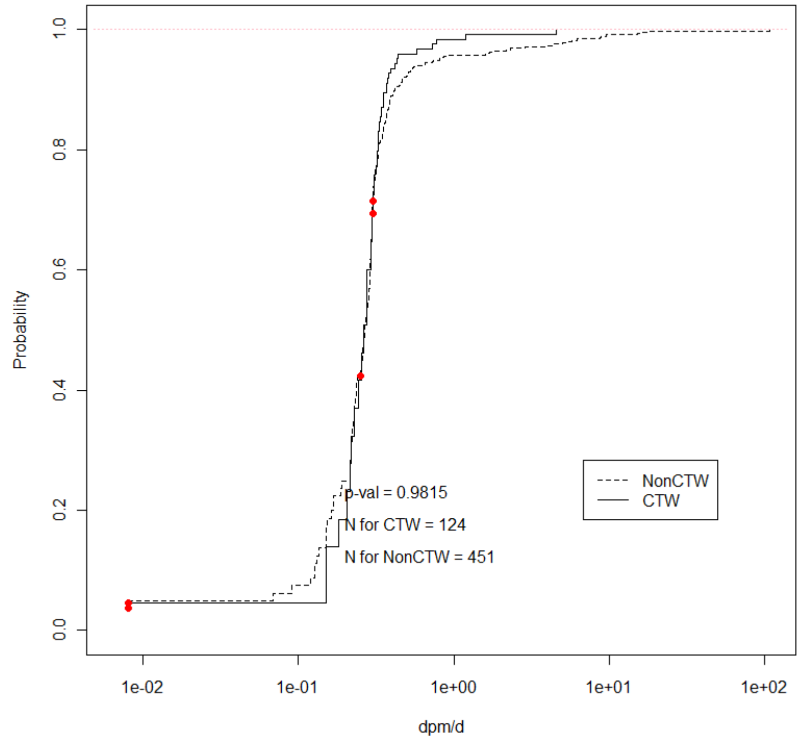

Figure B-3. Peto-Prentice test for CTW:nonCTW, 1970.

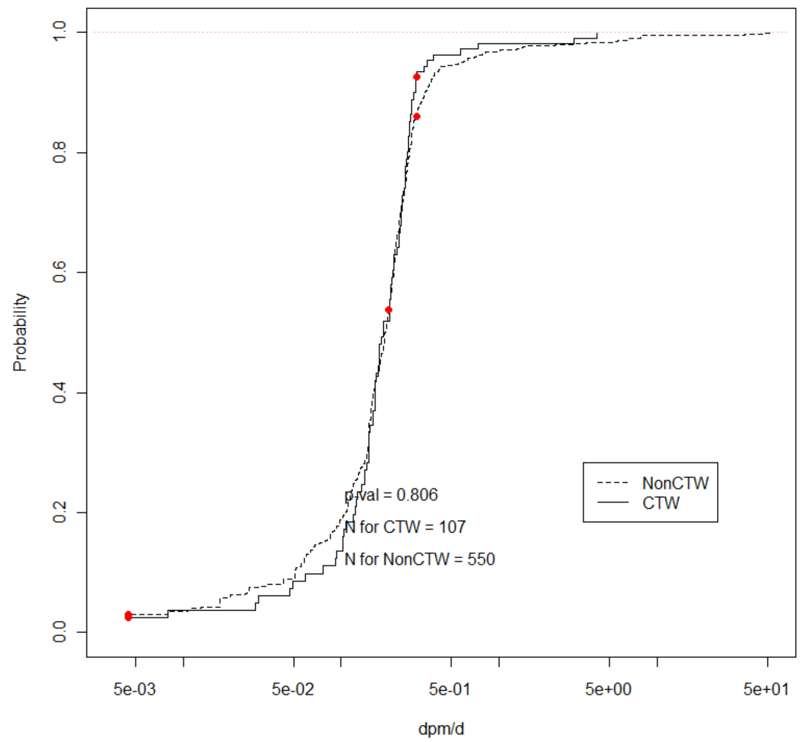

Figure B-4. Peto-Prentice test for CTW:nonCTW, 1971.

ATTACHMENT B
PETO-PRENTICE PLOTS FOR CTW:NONCTW AND CTW:NONCTW+UNK COMPARISONS

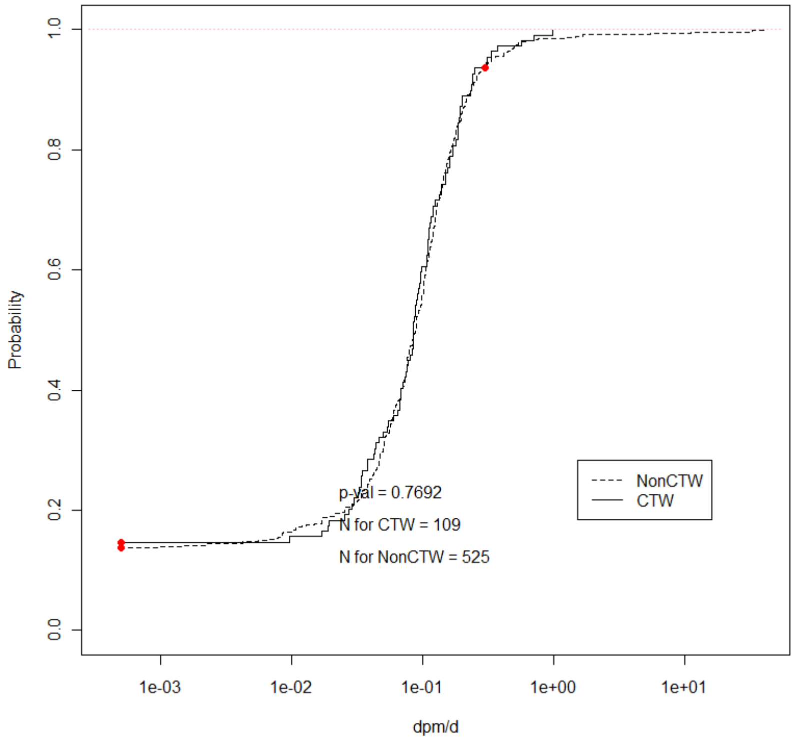

Figure B-5. Peto-Prentice test for CTW:nonCTW, 1972.

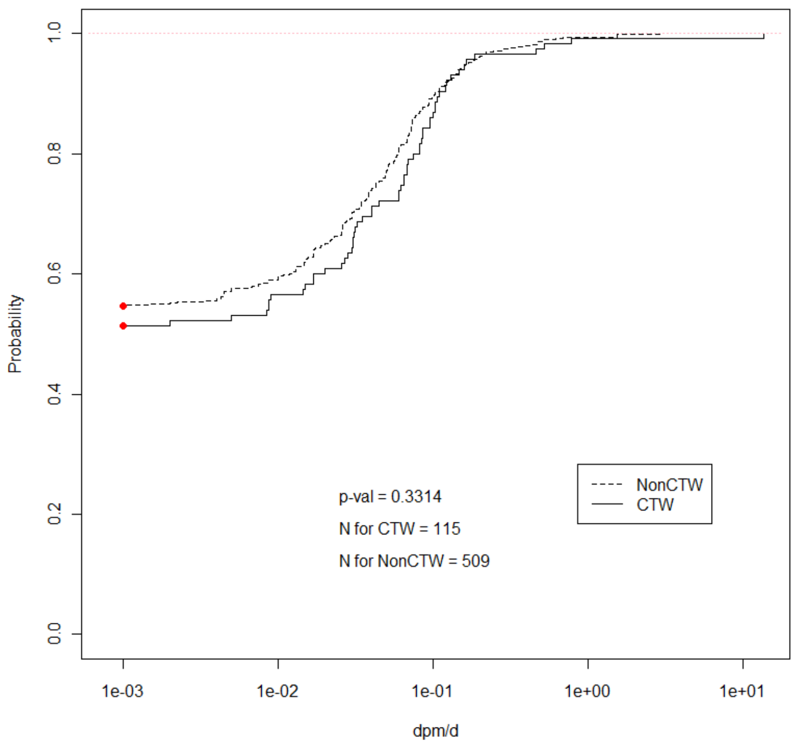

Figure B-6. Peto-Prentice test for CTW:nonCTW, 1973.

ATTACHMENT B
PETO-PRENTICE PLOTS FOR CTW:NONCTW AND CTW:NONCTW+UNK COMPARISONS

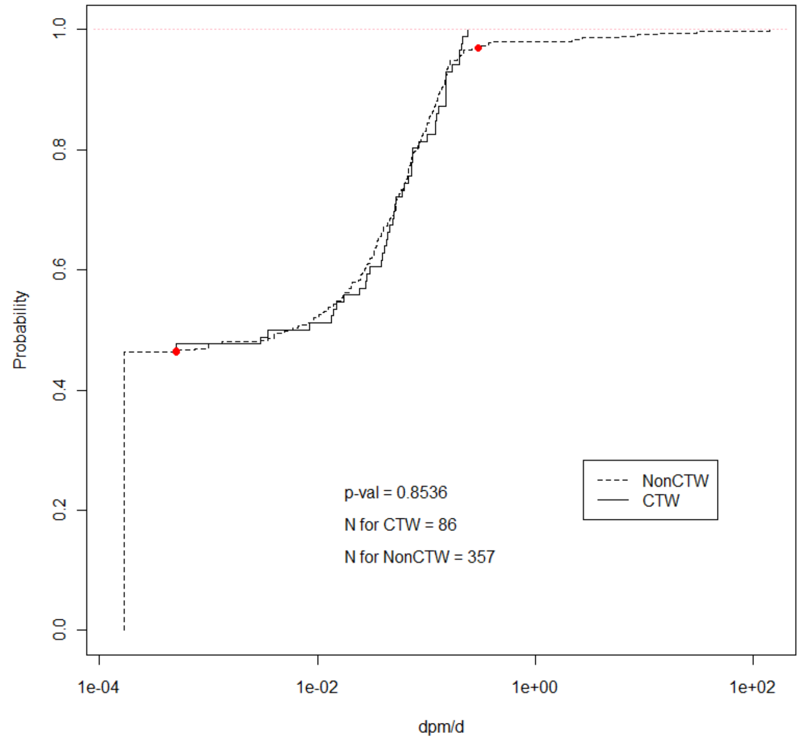

Figure B-7. Peto-Prentice test for CTW:nonCTW, 1974.

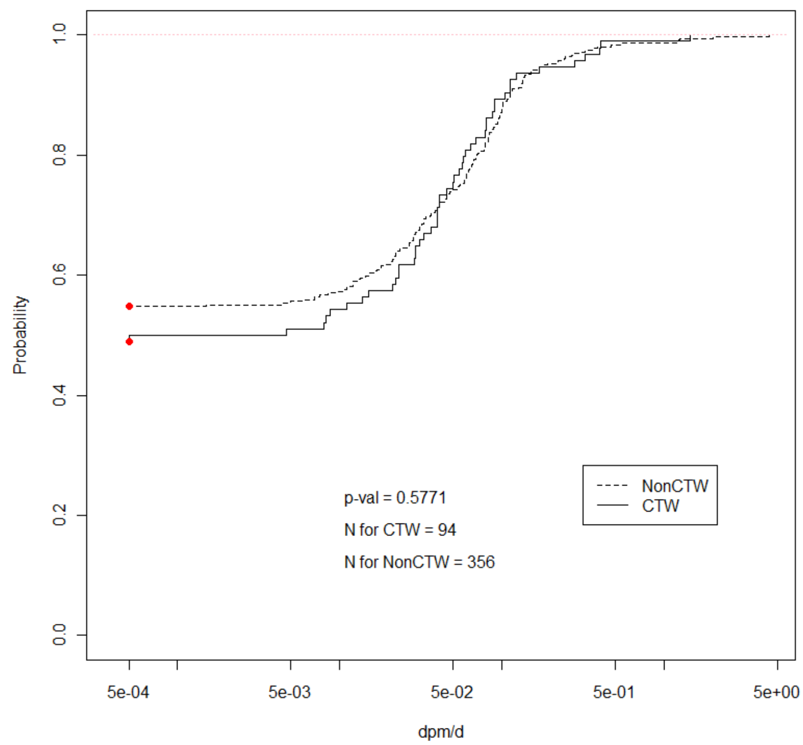

Figure B-8. Peto-Prentice test for CTW:nonCTW, 1975.

ATTACHMENT B
PETO-PRENTICE PLOTS FOR CTW:NONCTW AND CTW:NONCTW+UNK COMPARISONS

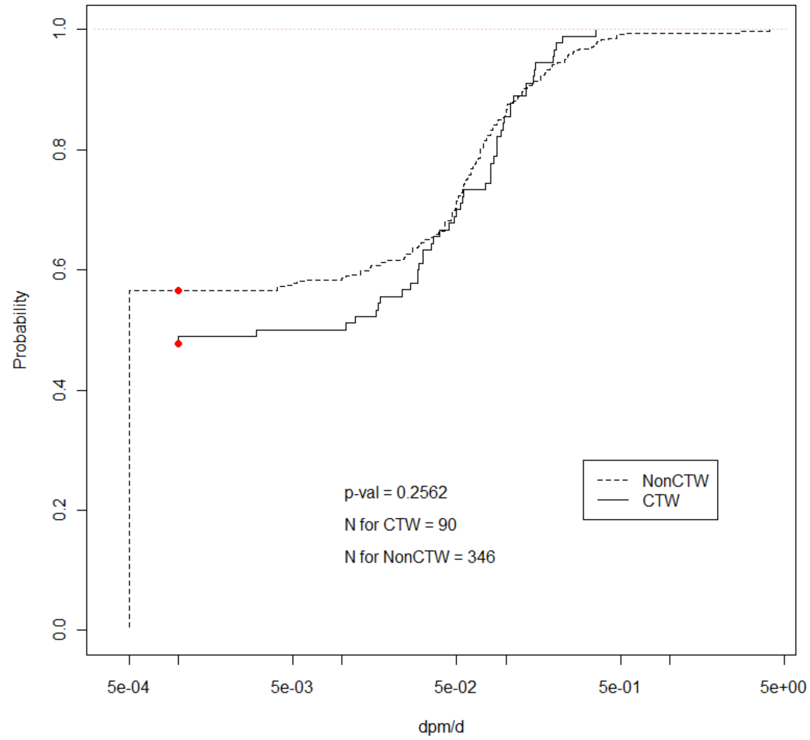

Figure B-9. Peto-Prentice test for CTW:nonCTW, 1976.

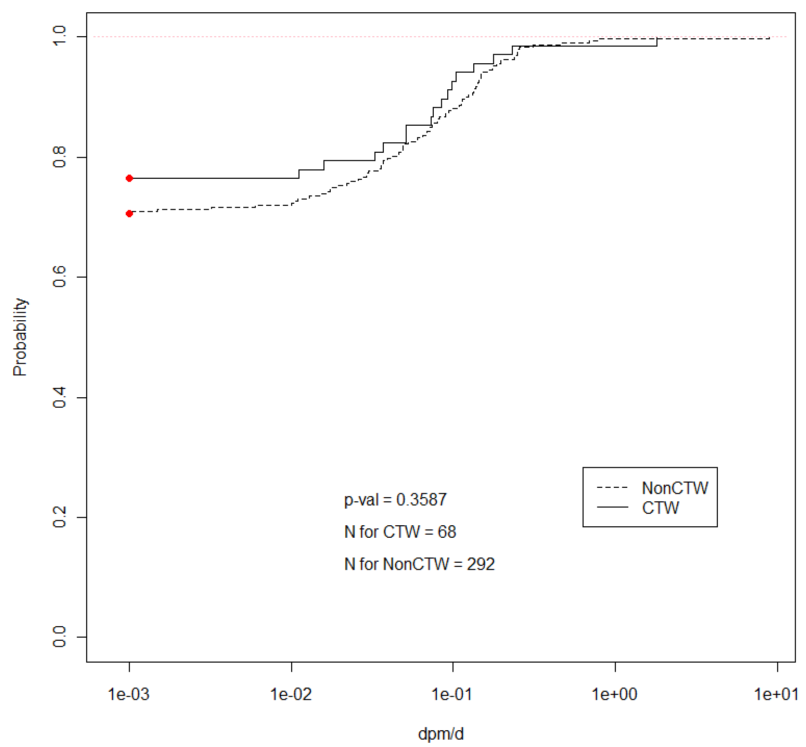

Figure B-10. Peto-Prentice test for CTW:nonCTW, 1977.

ATTACHMENT B
PETO-PRENTICE PLOTS FOR CTW:NONCTW AND CTW:NONCTW+UNK COMPARISONS

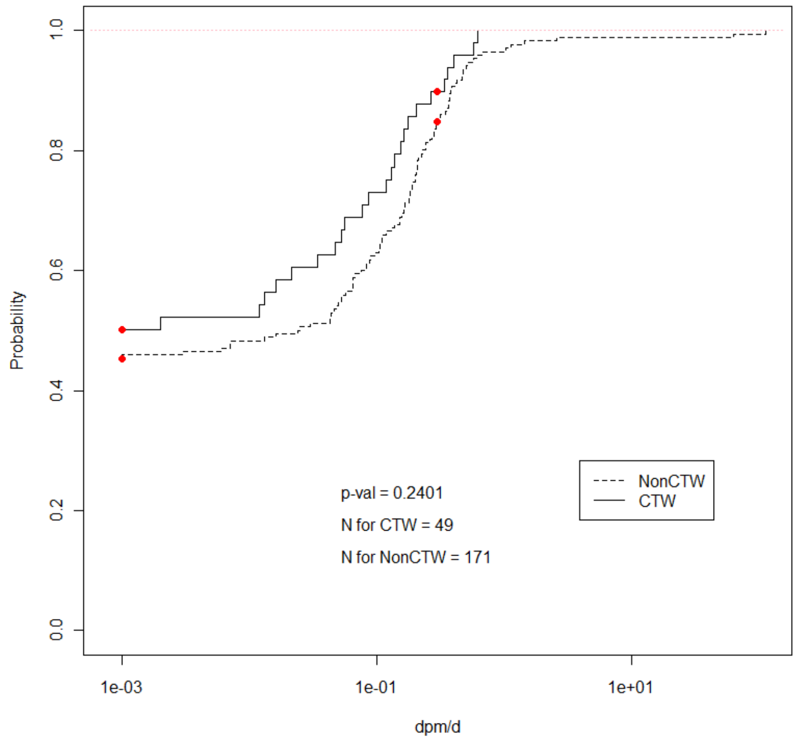

Figure B-11. Peto-Prentice test for CTW:nonCTW, 1978.

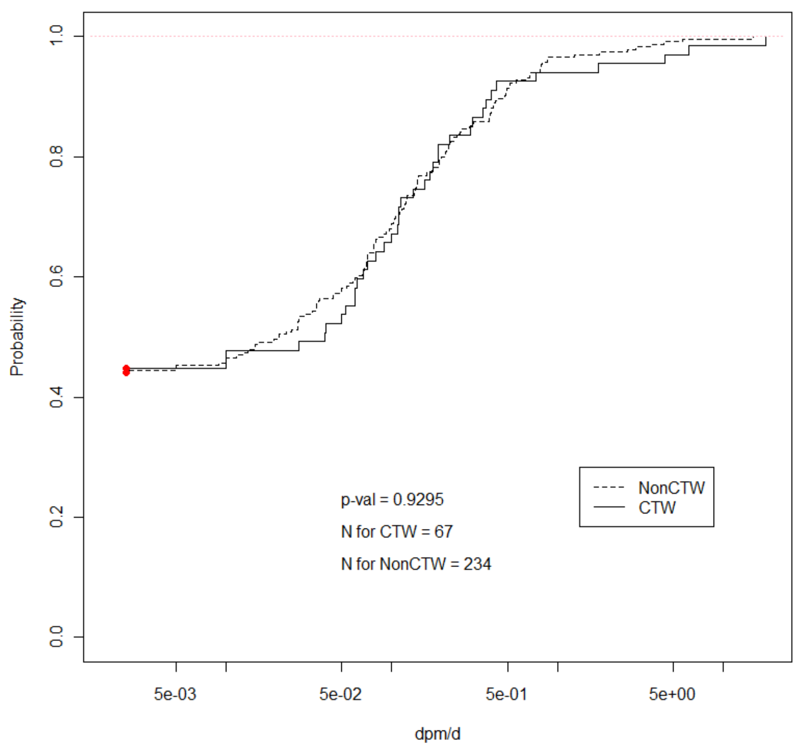

Figure B-12. Peto-Prentice test for CTW:nonCTW, 1979.

ATTACHMENT B
PETO-PRENTICE PLOTS FOR CTW:NONCTW AND CTW:NONCTW+UNK COMPARISONS

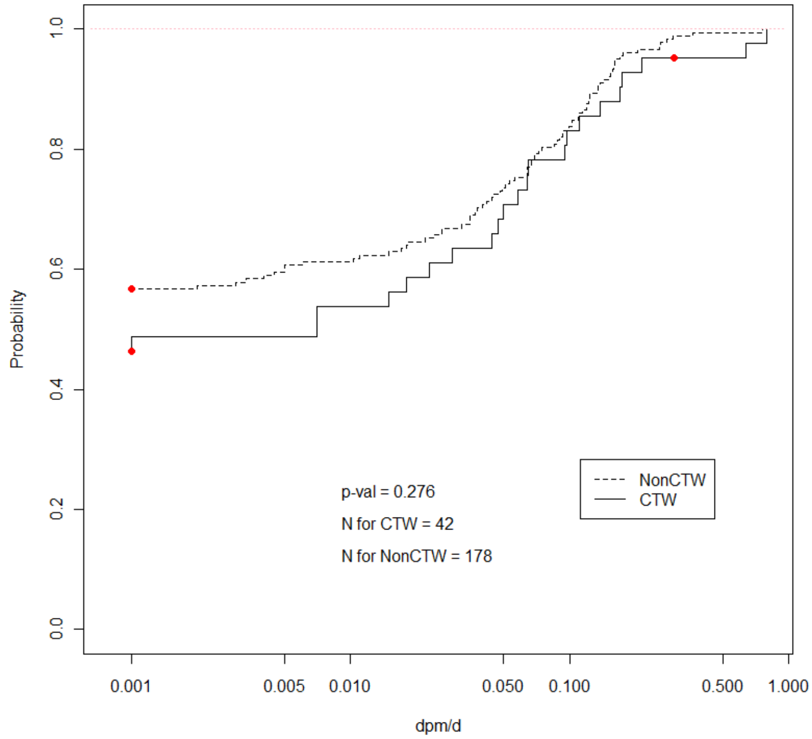

Figure B-13. Peto-Prentice test for CTW:nonCTW, 1980.

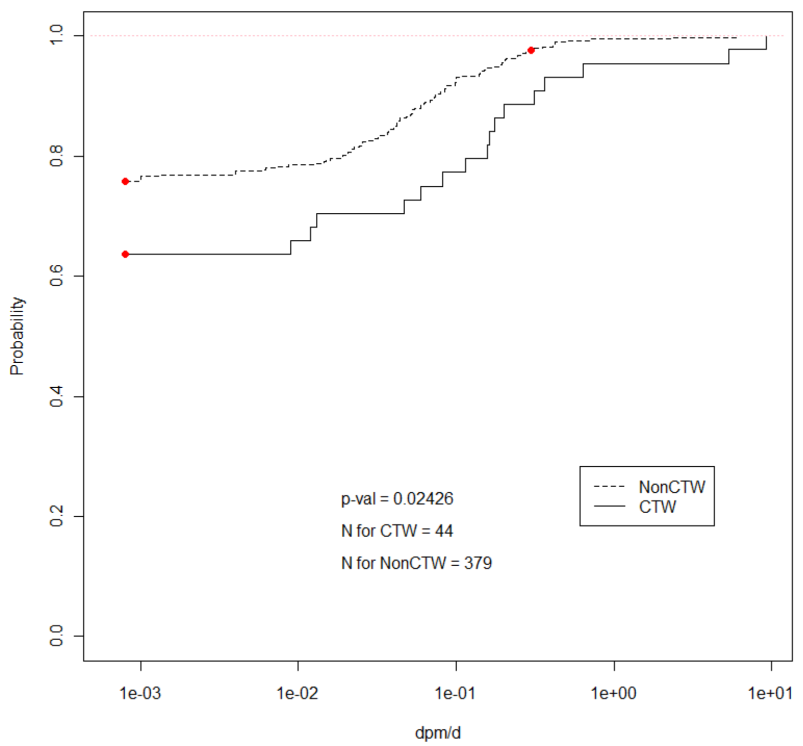

Figure B-14. Peto-Prentice test for CTW:nonCTW, 1981 to 1982.

ATTACHMENT B
PETO-PRENTICE PLOTS FOR CTW:NONCTW AND CTW:NONCTW+UNK COMPARISONS
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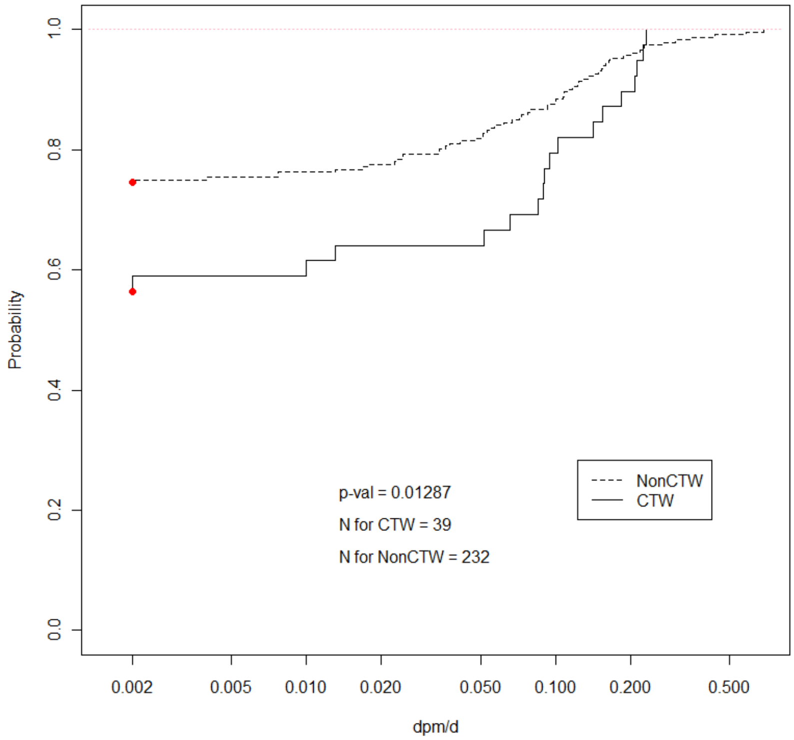

Figure B-15. Peto-Prentice test for CTW:nonCTW, 1983.

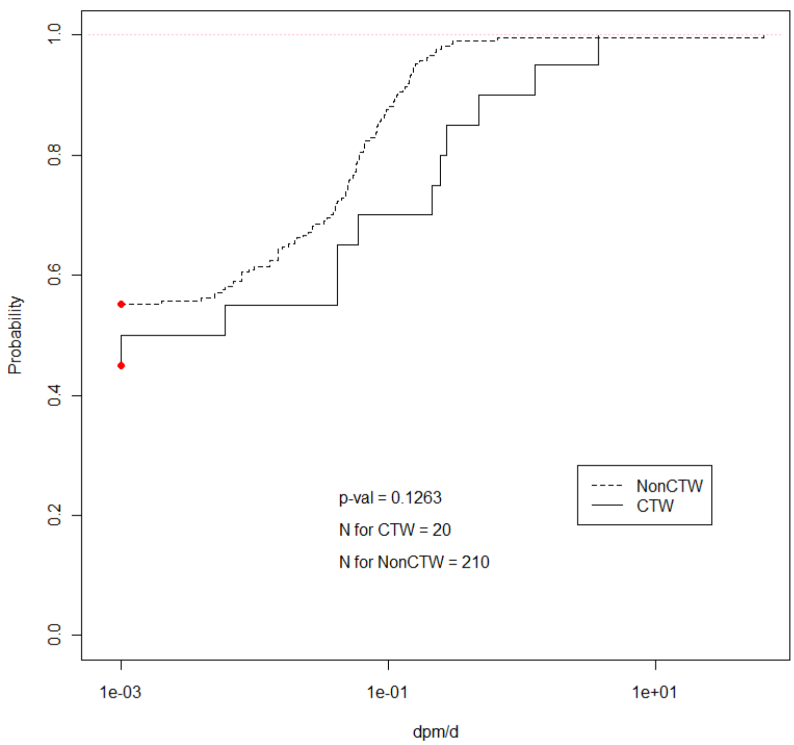

Figure B-16. Peto-Prentice test for CTW:nonCTW, 1984.

ATTACHMENT B
PETO-PRENTICE PLOTS FOR CTW:NONCTW AND CTW:NONCTW+UNK COMPARISONS

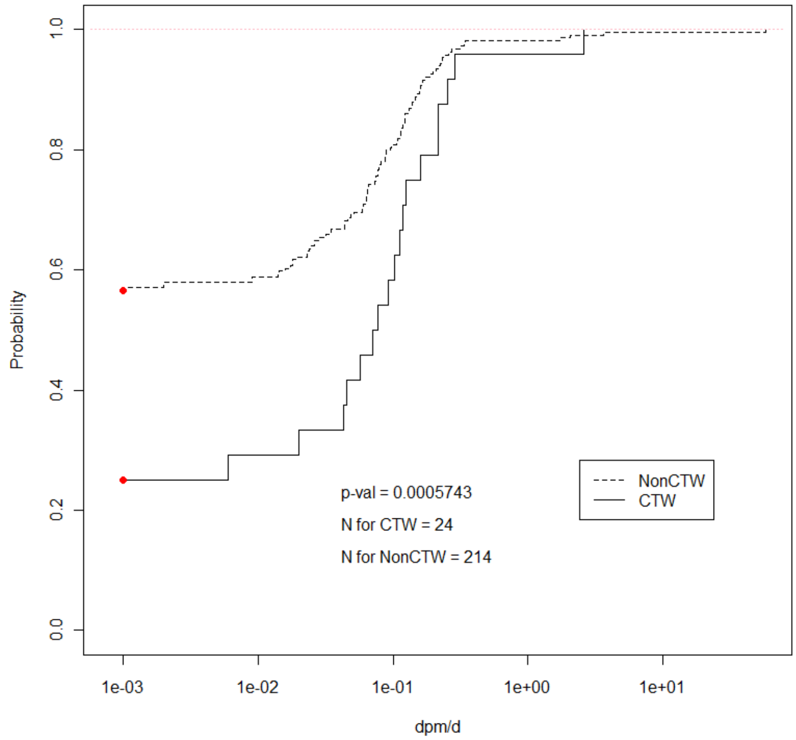

Figure B-17. Peto-Prentice test for CTW:nonCTW, 1985.

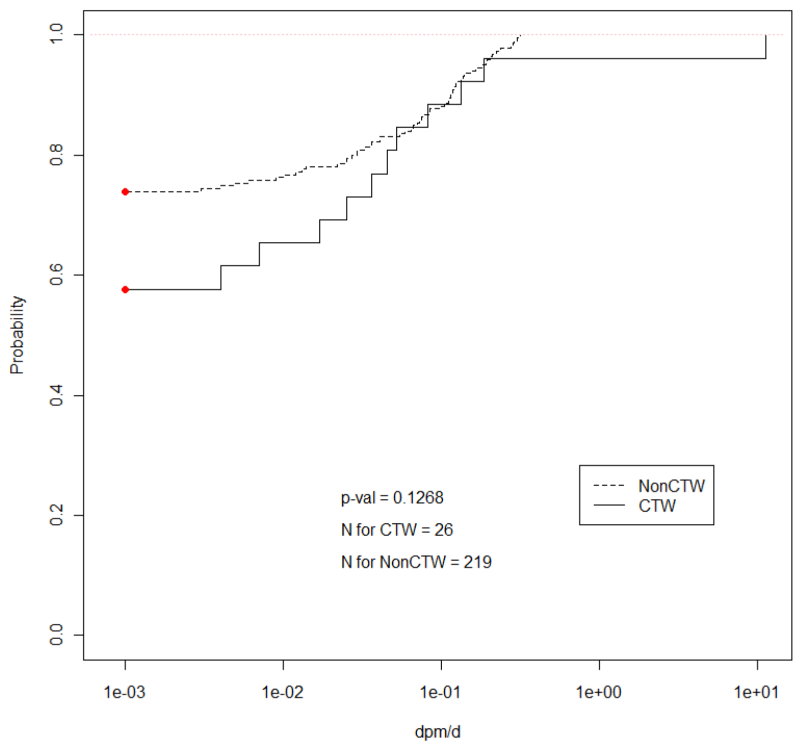

Figure B-18. Peto-Prentice test for CTW:nonCTW, 1986.

ATTACHMENT B
PETO-PRENTICE PLOTS FOR CTW:NONCTW AND CTW:NONCTW+UNK COMPARISONS

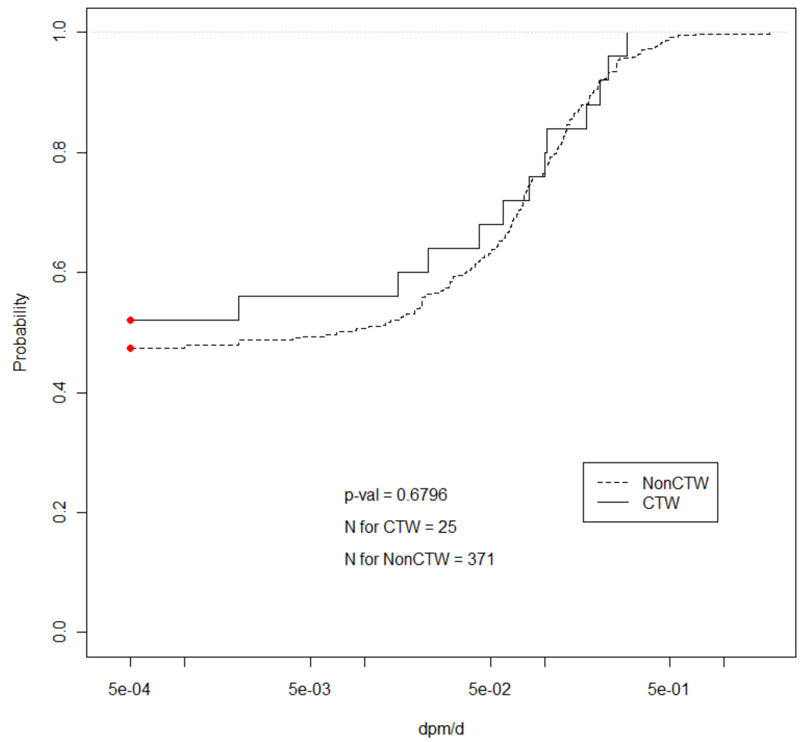

Figure B-19. Peto-Prentice test for CTW:nonCTW, 1987 to 1989.

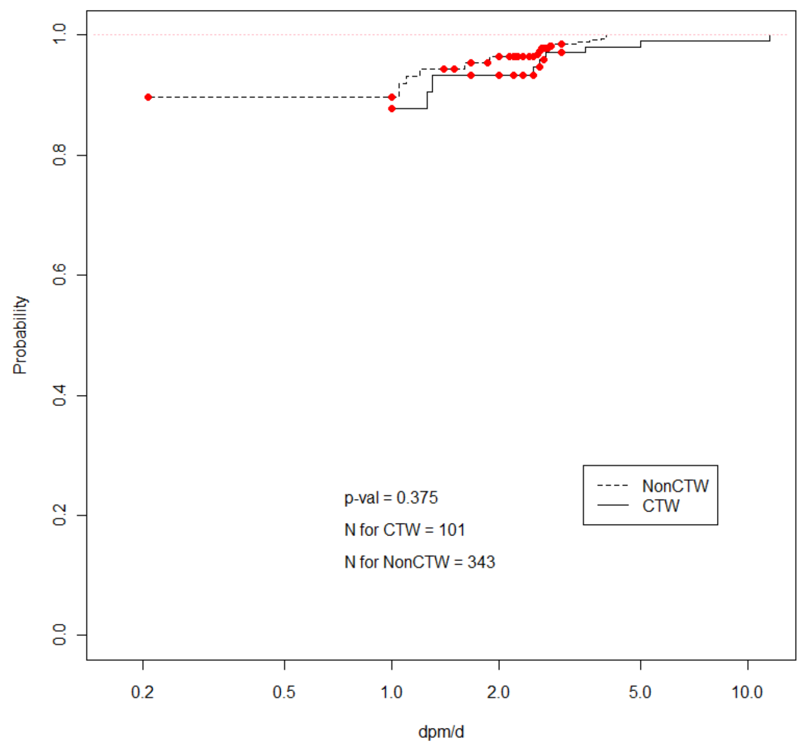

Figure B-20. Peto-Prentice test for CTW:nonCTW+unk, 1966 to 1968.

ATTACHMENT B
PETO-PRENTICE PLOTS FOR CTW:NONCTW AND CTW:NONCTW+UNK COMPARISONS

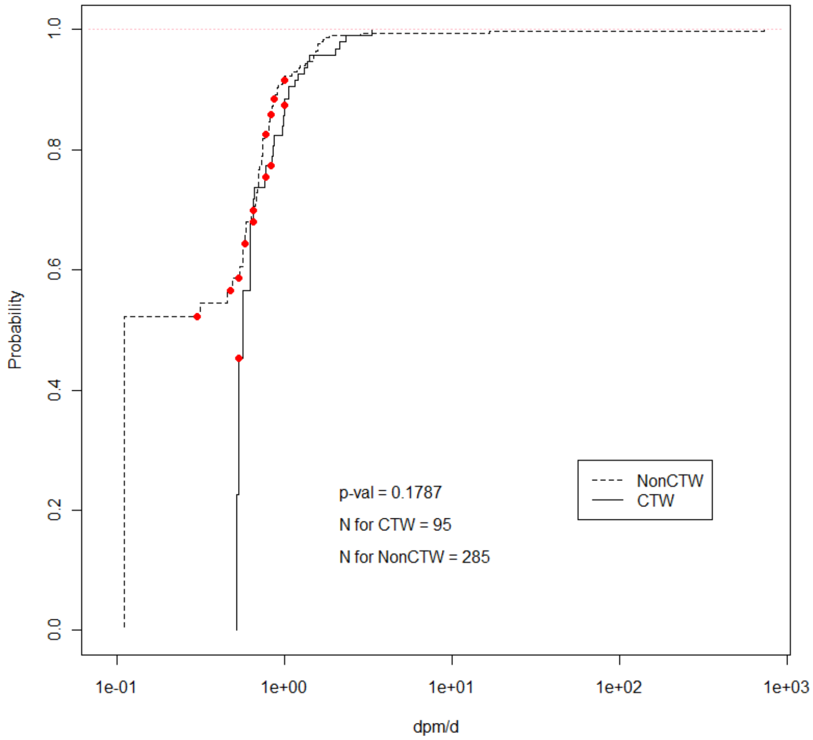

Figure B-21. Peto-Prentice test for CTW:nonCTW+unk, 1969.

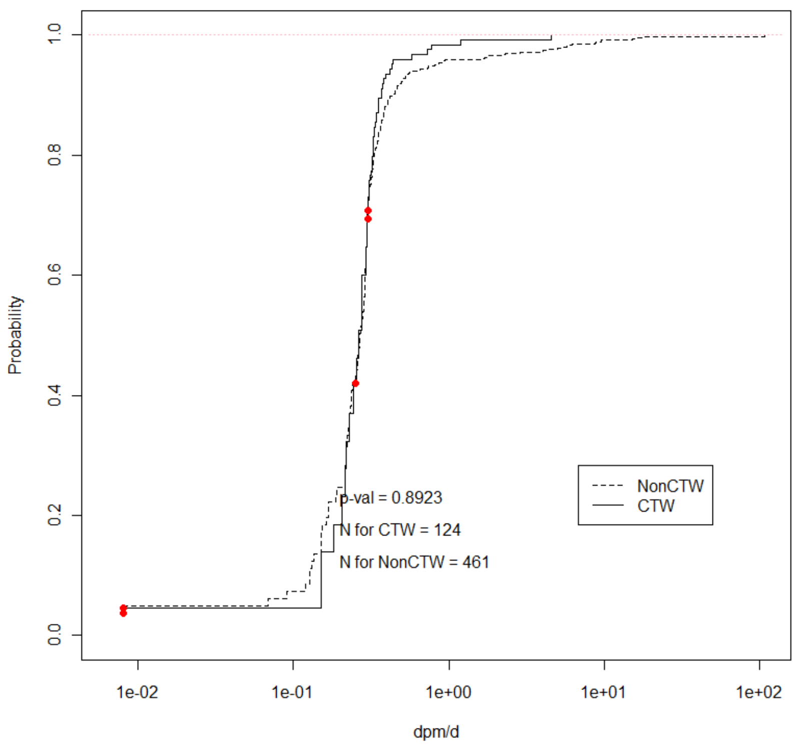

Figure B-22. Peto-Prentice test for CTW:nonCTW+unk, 1970.

ATTACHMENT B
PETO-PRENTICE PLOTS FOR CTW:NONCTW AND CTW:NONCTW+UNK COMPARISONS
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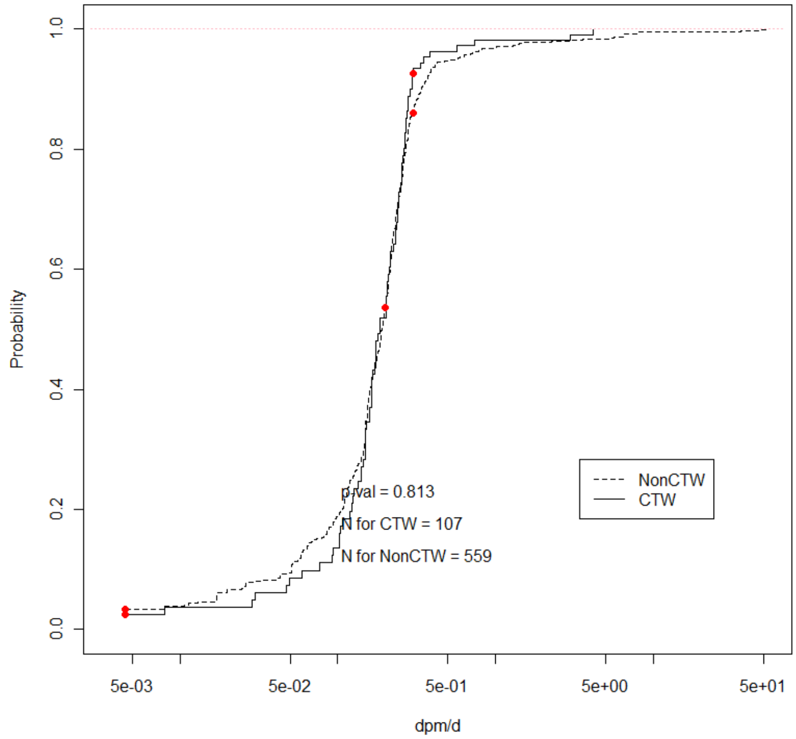

Figure B-23. Peto-Prentice test for CTW:nonCTW+unk, 1971.

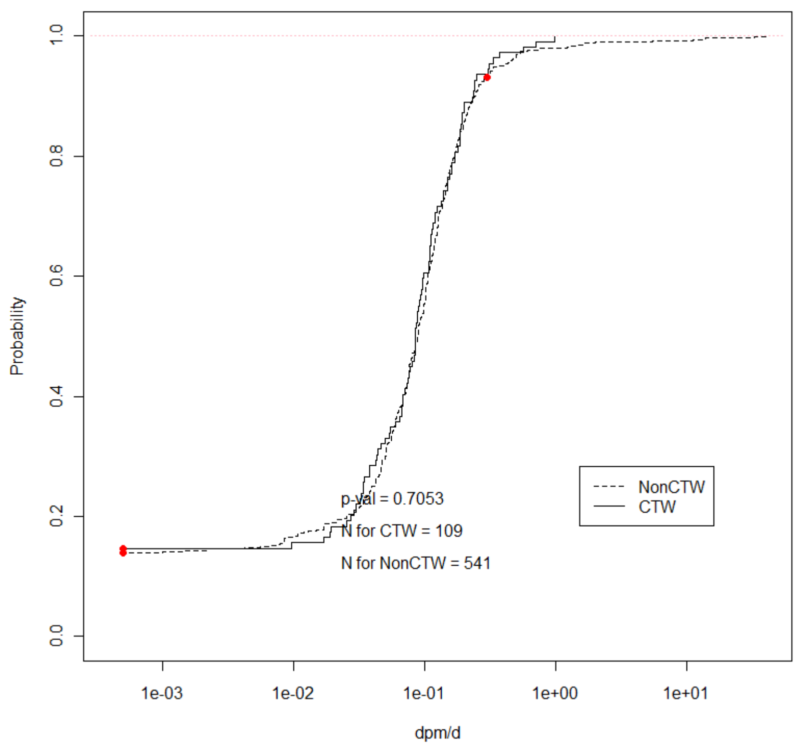

Figure B-24. Peto-Prentice test for CTW:nonCTW+unk, 1972.

ATTACHMENT B
PETO-PRENTICE PLOTS FOR CTW:NONCTW AND CTW:NONCTW+UNK COMPARISONS

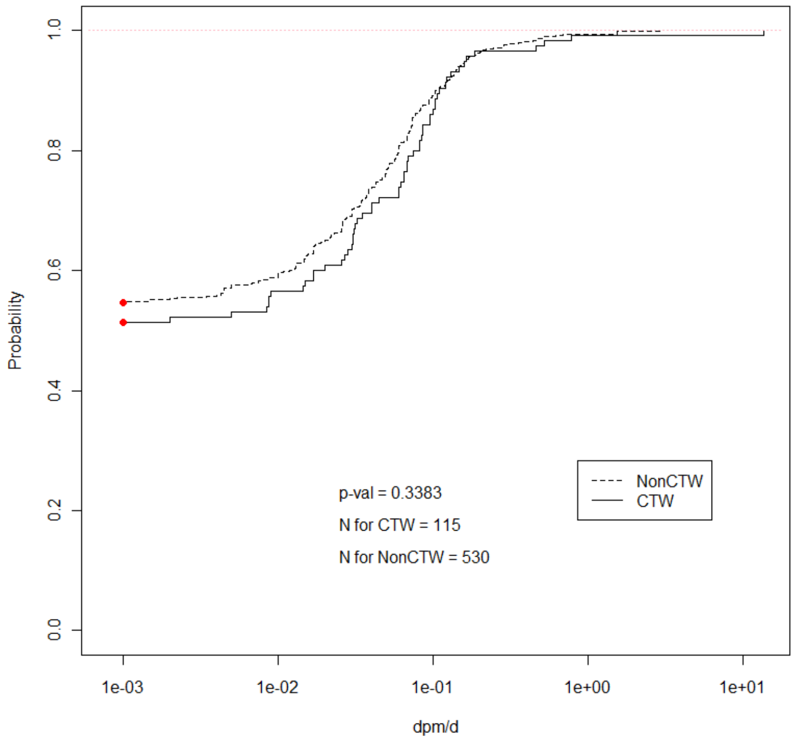

Figure B-25. Peto-Prentice test for CTW:nonCTW+unk, 1973.

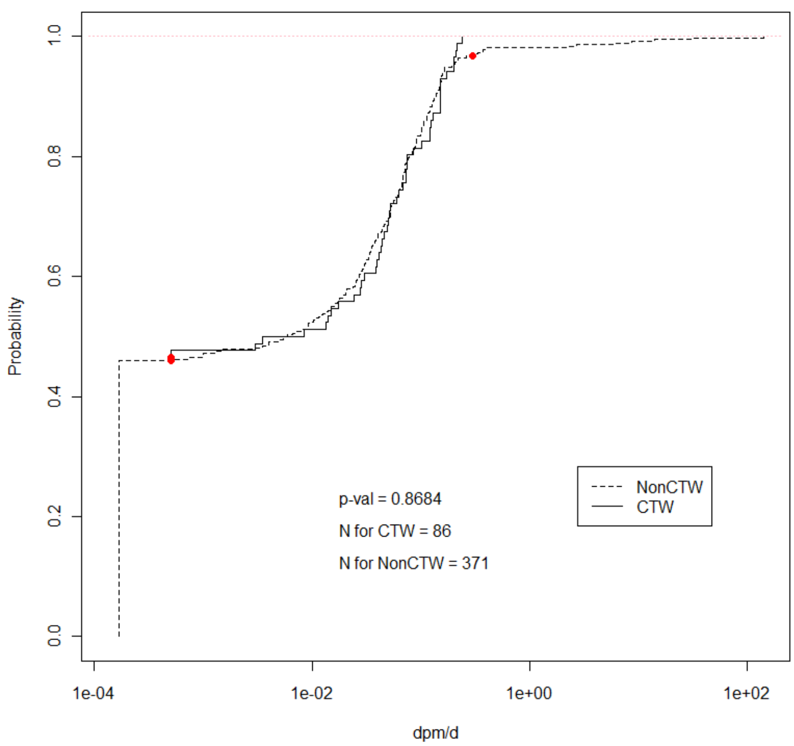

Figure B-26. Peto-Prentice test for CTW:nonCTW+unk, 1974.

ATTACHMENT B
PETO-PRENTICE PLOTS FOR CTW:NONCTW AND CTW:NONCTW+UNK COMPARISONS

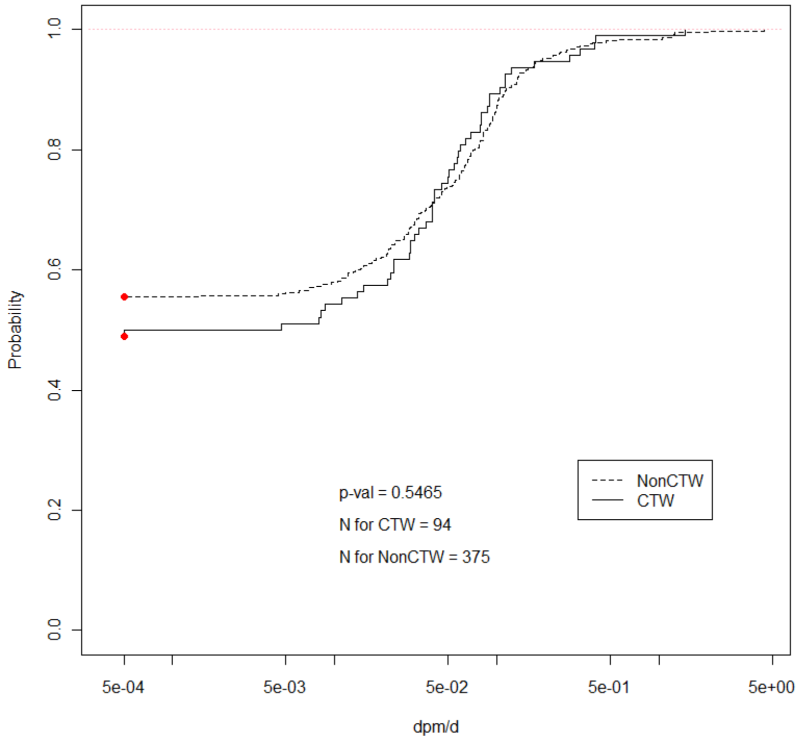

Figure B-27. Peto-Prentice test for CTW:nonCTW+unk, 1975.

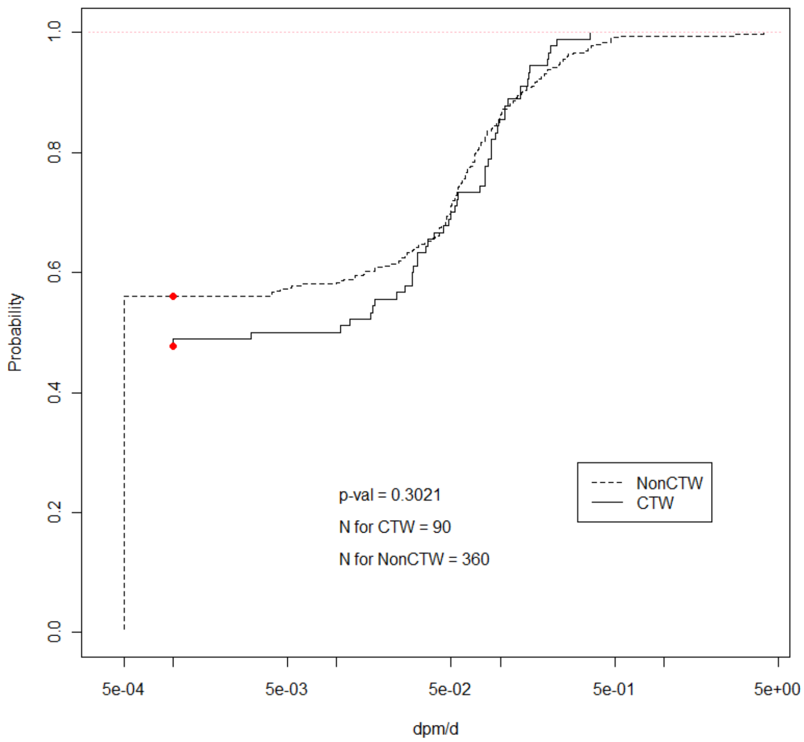

Figure B-28. Peto-Prentice test for CTW:nonCTW+unk, 1976.

ATTACHMENT B
PETO-PRENTICE PLOTS FOR CTW:NONCTW AND CTW:NONCTW+UNK COMPARISONS

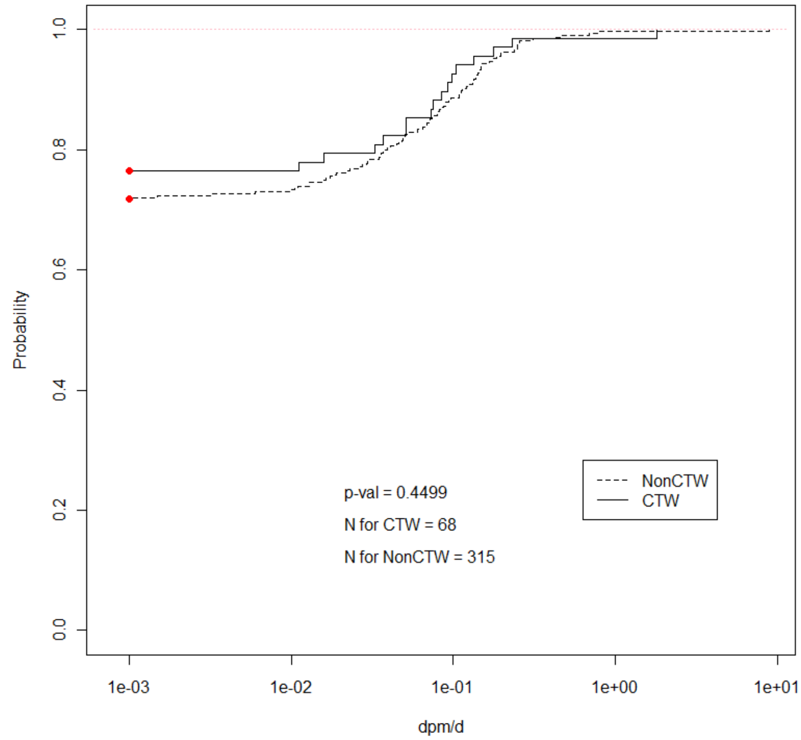

Figure B-29. Peto-Prentice test for CTW:nonCTW+unk, 1977.

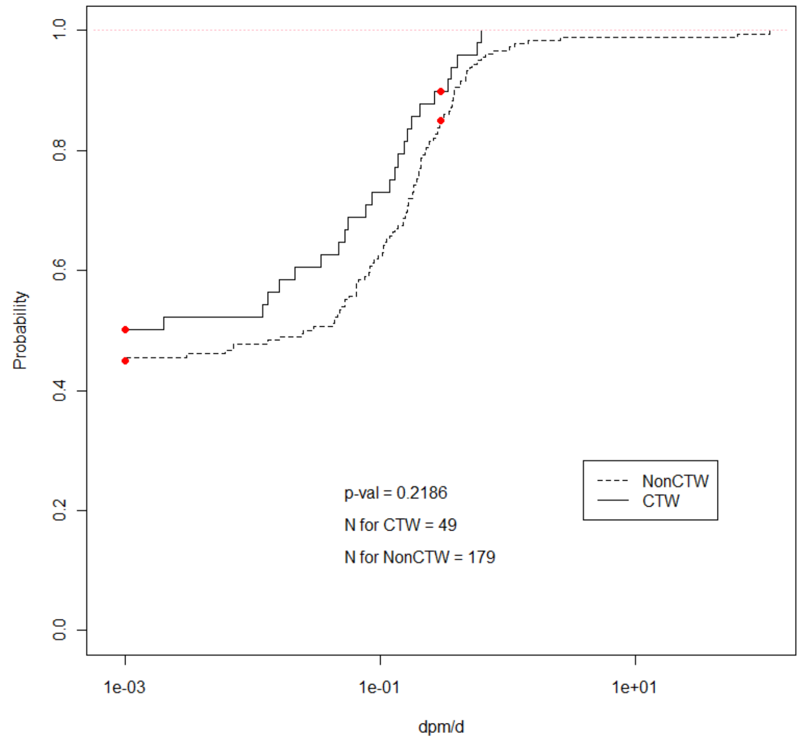

Figure B-30. Peto-Prentice test for CTW:nonCTW+unk, 1978.

ATTACHMENT B
PETO-PRENTICE PLOTS FOR CTW:NONCTW AND CTW:NONCTW+UNK COMPARISONS

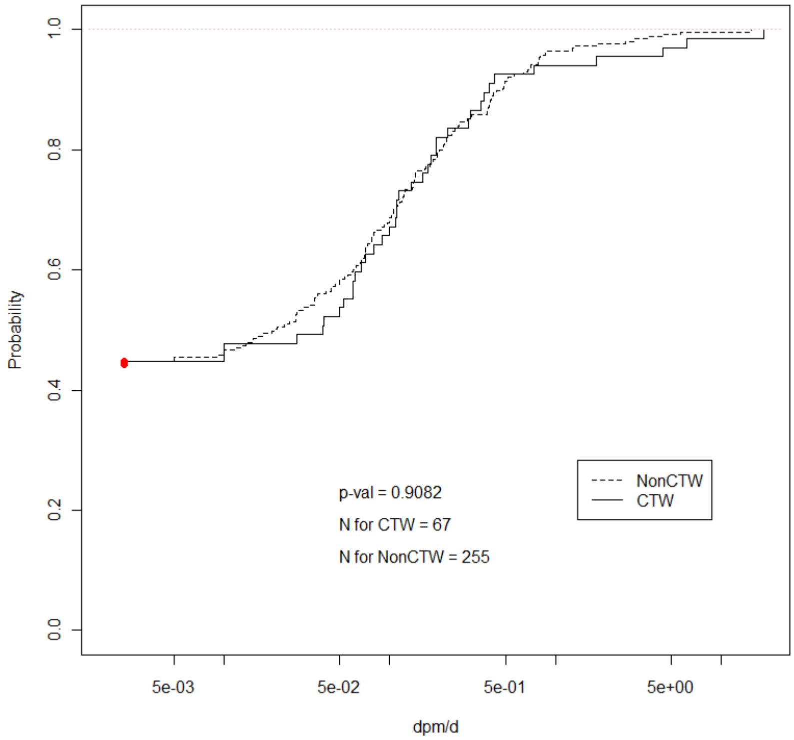

Figure B-31. Peto-Prentice test for CTW:nonCTW+unk, 1979.

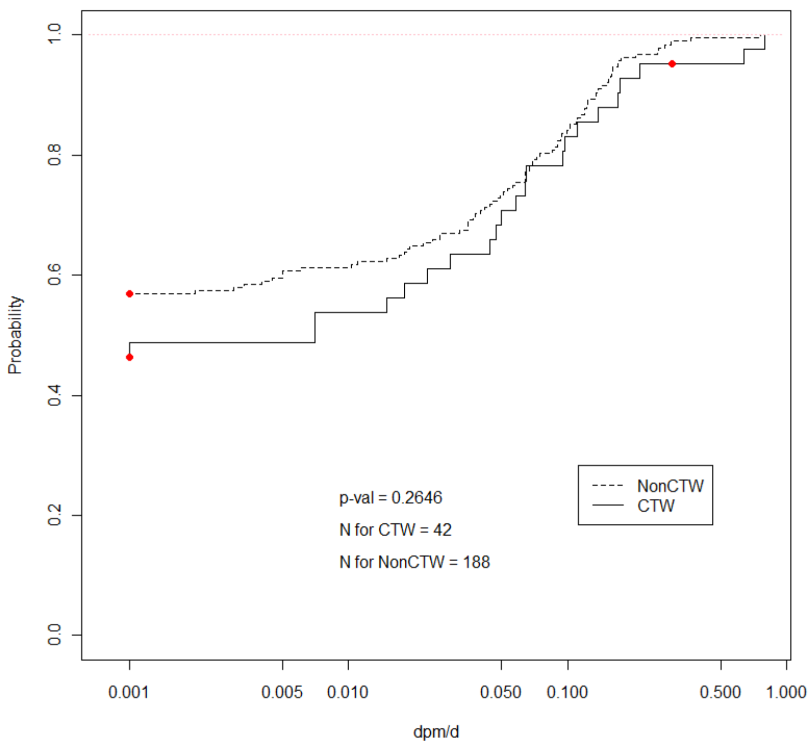

Figure B-32. Peto-Prentice test for CTW:nonCTW+unk, 1980.

ATTACHMENT B
PETO-PRENTICE PLOTS FOR CTW:NONCTW AND CTW:NONCTW+UNK COMPARISONS

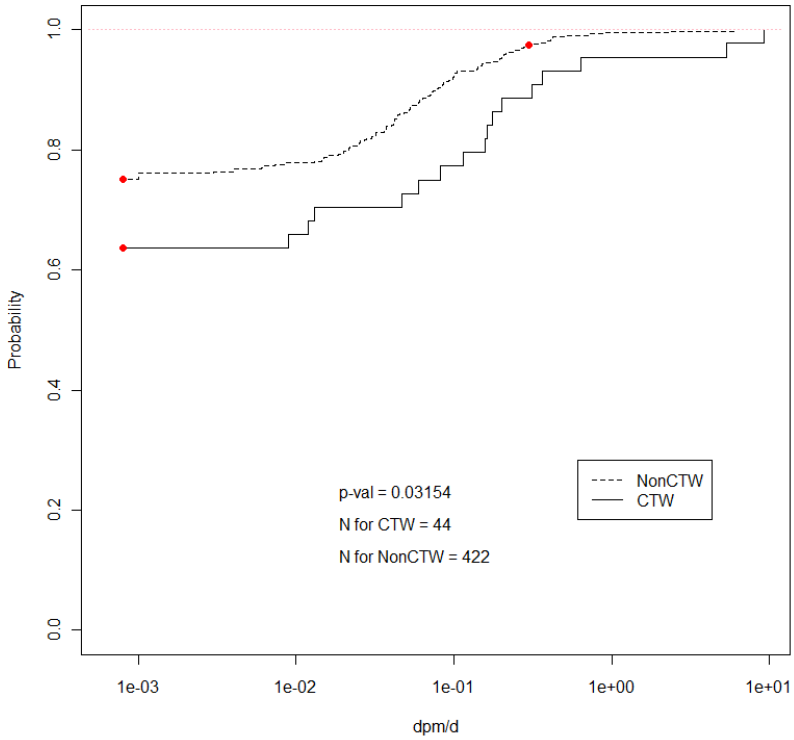

Figure B-33. Peto-Prentice test for CTW:nonCTW+unk, 1981 to 1982.

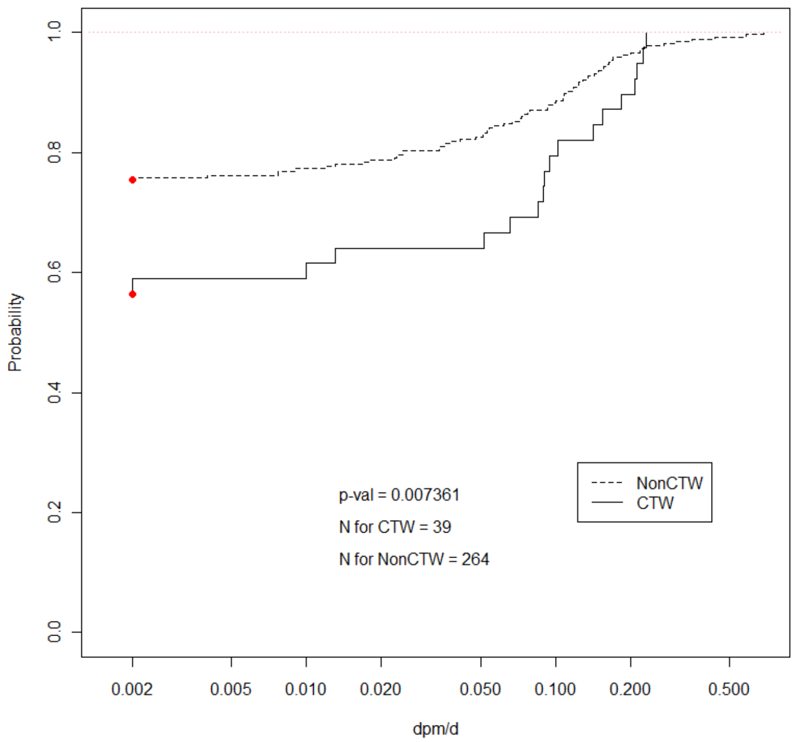

Figure B-34. Peto-Prentice test for CTW:nonCTW+unk, 1983.

ATTACHMENT B
PETO-PRENTICE PLOTS FOR CTW:NONCTW AND CTW:NONCTW+UNK COMPARISONS

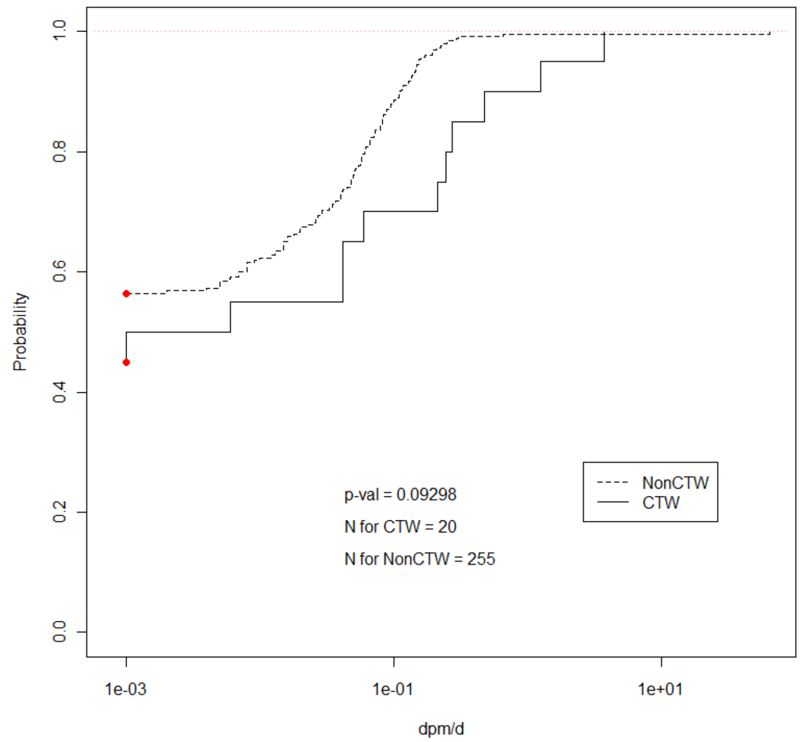

Figure B-35. Peto-Prentice test for CTW:nonCTW+unk, 1984.

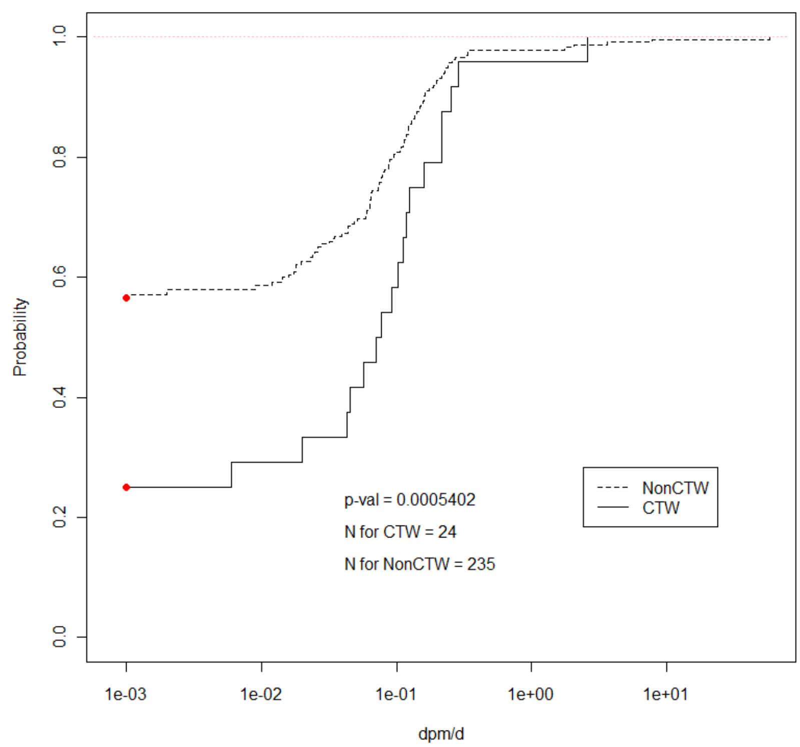

Figure B-36. Peto-Prentice test for CTW:nonCTW+unk, 1985.

ATTACHMENT B
PETO-PRENTICE PLOTS FOR CTW:NONCTW AND CTW:NONCTW+UNK COMPARISONS

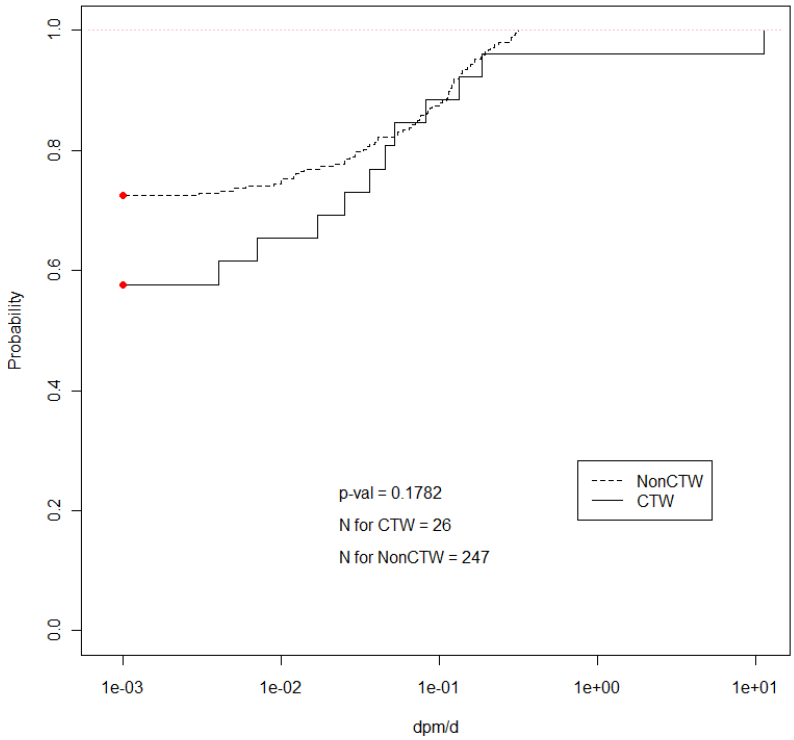

Figure B-37. Peto-Prentice test for CTW:nonCTW+unk, 1986.

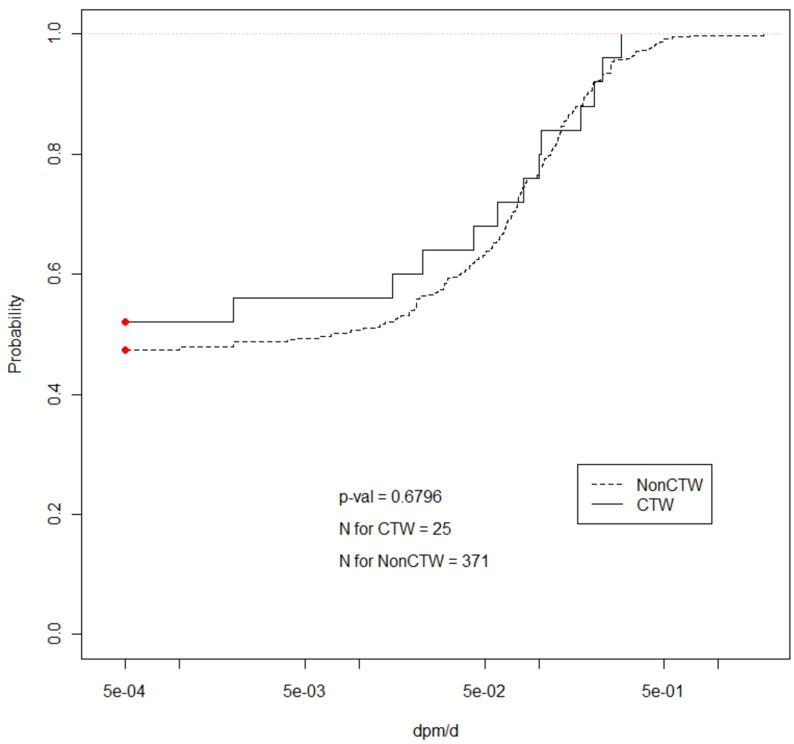

Figure B-38. Peto-Prentice test for CTW:nonCTW+unk, 1987 to 1989.