Chapter 240

Nondetects-Data Group Comparison

Introduction

This procedure computes summary statistics, generates EDF plots, and computes hypothesis tests appropriate for two or more groups for data with nondetects (left-censored) values. Following the recommendation of Helsel (2005), pp. 77-78, the methods for this procedure are valid only if fewer than 50% of the values are nondetects (left-censored).

Nondetects analysis is the analysis of data in which one or more of the values cannot be measured exactly because they fall below one or more detection limits. Detection limits often arise in environmental studies because of the inability of instruments to measure small concentrations. Some examples of sampling scenarios that lead to datasets with nondetects values are finding pesticide concentrations in water, determining chemical composition of soils, or establishing the number of particulates of a compound in the air.

A common practice for dealing with values which fall below the detection threshold is substitution. Often, each value which is below the detection limit is substituted with one half the detection limit. Summary statistics and comparisons are then carried out using standard techniques (means, confidence intervals, t-tests, ANOVA, etc.) with the substituted data. Helsel (2005) warns of the potential data analysis biases that result if nondetects values are substituted. He particularly warns about the arbitrariness of substituting one half the detection limit (or zero, or the detection limit). Alternatively, techniques based on survival analysis methods have been developed for appropriate use of the information contained in the nondetected observations. The general approach is to convert the nondetects data (left-censored) to survival data (right-censored), use the survival analysis techniques on the newly created survival data, and then convert the survival summaries back to original scale (In *NCSS*, these conversions are performed automatically). The resulting summary statistics and hypothesis tests are analogs to the common techniques, but which appropriately account for nondetected observations. For example, medians are used rather than means, EDF plots replace box plots and histograms, and logrank tests are used instead of two-sample t-tests and ANOVA.

The technical details of survival analysis are found in the Kaplan-Meier Survival Curves chapter. For a complete account of nondetects analysis, we suggest the book by Helsel (2005).

Technical Details

Flipping Constant

To convert nondetects data to the format of survival data, each response, including nondetected values, must be subtracted from a suitable flipping constant. The flipping constant can be any number which is larger than the maximum of the nondetects data. The resulting right-censored data are

$$Flip_i = M - x_i,$$

where M is the flipping constant and the x_i are the original observations.

For example, consider the first 10 of 25 dioxin concentrations (fg/cubic meter) with lower detection limit 50 fg/cubic meter (these data can be found in the DIOXIN dataset):

DIOXIN dataset (subset)

Dioxin
391
724
603
50
482
656
50
797
190
444

A suitable flipping constant is any value larger then the maximum value. Suppose M = 1000 is arbitrarily chosen as the flipping constant. The flipped data would then become

Dioxin	*M* – Dioxin	Flip
391	1000 – 391	609
724	1000 – 724	276
603	1000 – 603	397
<50	1000 – <50	>950
482	1000 – 482	518
656	1000 – 656	344
<50	1000 – <50	>950
797	1000 – 797	203
190	1000 – 190	810
444	1000 – 444	556
.	.	.
.	.	.
.	.	.

The flipped data is now in the survival data format.

Once the data are converted to the survival data format, the nonparametric Kaplan-Meier methods can be used for estimating summary statistics (i.e., median, quantiles, standard errors, confidence limits), and for group comparisons. The summary statistics of location (i.e., median, quantiles, and confidence limits) are converted back to the original scale using the same flipping constant M. For example, to convert the median of the survival data to the median of the original units, the formula

$$Median = M - SurvivalMedian$$

is used. For the Dioxin data, the survival median (of the flipped data) is 556 fg/cubic meter. The median on the original scale would then be Median = 1000 – 556 = 444 fg/cubic meter. The standard error statistics for the flipped survival data are the same as those of the original scale, and need not be converted. All of the calculations involving conversion and re-conversion based on the flipping constant are done automatically in *NCSS*.

The Empirical Distribution Function (EDF)

The empirical distribution function (EDF) provides an approximation of the true cumulative distribution function of the measured response. It is useful for viewing or obtaining sample percentiles (quantiles) for each of the observed responses. The EDF is produced using the Kaplan-Meier product-limit estimator (estimated survival distribution) of the flipped data. The resulting survival distribution is then converted to the EDF by re-subtracting all values from the flipping constant. We now examine the technical details of the estimation of the survival distribution.

Hypothesis Tests

This section presents methods for testing that the distribution functions of two or more populations are equal. The null hypothesis is that the distribution functions of all populations are equal at all values greater than the minimum observed value. The alternative hypothesis is that at least two of the distribution functions are different at some value greater than the observed minimum value.

Five different choices of tests are available in ***NCSS*** to test the above hypotheses. The tests differ in the manner in which different responses are weighted. The most commonly used test is the logrank test, which has equal weighting. The other four tests shift the heaviest weighting to the larger or smaller responses. Although five tests are displayed, only one should be used. Because of the different weighting patterns, they will often give quite different results. The test that will be used should be justified and designated before viewing the data or test results.

The following table describes the weighting scheme for each of these tests.

Test	Comments
Logrank	This is the most commonly used test and the one we recommend. Equal weights across all times are used.
Gehan	Places very heavy weight on large responses.
Tarone-Ware	Places heavy weight on small responses.
Peto-Peto	Places a little more weight on large responses.
Modified Peto-Peto	Places a little more weight on large responses.

Data Structure

Nondetects datasets are specified using up to four components: the response value (e.g., concentration or amount), an optional indicator of whether or not each observation was detected, an optional group specification, and an optional frequency (count) specification. If no detection indicator is included, all response values represent detected responses. If there is no group specification, a single group is assumed. If the frequency (count) variable is omitted, all counts are assumed to be one.

Sample Dataset

The table below shows a dataset (fictitious) reporting sediment arsenic concentrations for three different regions of a lake. A single sample was taken from each of twenty randomly selected locations of each region. In this dataset, the response is the concentration of arsenic in mg/Kg (dry weight). The instruments used in the study to determine arsenic concentration are unable to detect concentrations below 10 mg/Kg. A value of zero in the ANondet column indicates arsenic was detected. A value of one in the ANondet column indicates arsenic was not detected. These data are contained in the ARSENIC dataset.

Arsenic dataset (subset)

Arsenic	ANondet	Region
14	0	1
10	1	1
31	0	1
26	0	1
10	1	1
.	.	.
.	.	.
.	.	.
15	0	2
10	1	2
25	0	2
21	0	2
27	0	2
.	.	.
.	.	.
.	.	.
29	0	2
26	0	2
18	0	3
26	0	3
.	.	.
.	.	.
.	.	.

Procedure Options

This section describes the options available in this procedure.

Variables Tab

This panel specifies the variables used in the analysis.

Response Variable

Response Variable

The values of this variable represent either the magnitude of a detected observations or detection limits, depending on the corresponding values of the Nondetection (Censor) Variable.

The values in this variable must be greater than zero. If the value is missing or non-positive, it is not used during the estimation phase.

Nondetection Variable

Nondetection (Censor) Variable

The values in this variable indicate whether the value of the Response Variable represents a nondetected (censored) observation or a detected observation. When a particular value of this variable indicates a Nondetect, the corresponding value of the Response Variable represents a lower detection limit.

These values may be text or numeric. The interpretation of these codes is specified by the 'Detected' and 'Not Detected' (Censored) options to the right of this option.

Only two values are used, the Detected value and the Not Detected value. The Unknown Censor option specifies what is to be done with values that do not match either the Detected value or the Not Detected value.

Rows with missing values (blanks) in this variable are omitted from the estimation phase, but results are shown in any reports that output predicted values.

Detected

When this value is encountered under the Nondetection (Censor) Variable it indicates that the value under the Response Variable was observed or detected. The value may be a number or a letter.

We suggest the letter 'D' or the number '0' when you are in doubt as to what to use.

A detected observation is one in which the value was measured exactly; for example, the concentration was such that the instrument was able to measure it.

Not Detected

When this value is encountered under the Nondetection (Censor) Variable it indicates that the value under the Response Variable was not actually observed (i.e., a nondetect) but represents a lower detection limit. That is, the observation is left-censored, and the actual value of the response is something below the detection limit.

The value may be a number or a letter. We suggest the letter 'N' or the number '1' when you are in doubt as to what to use.

A nondetect is a response in which the value was not measured exactly; for example, the concentration was such that the instrument was not able to measure it.

Unknown Censor

This option specifies what the program is to assume about observations whose Nondetection (Censor) Variable value is not equal to either the Detected code or the Not Detected code. Note that observations with missing Nondetection (Censor) values are always treated as missing.

- **Not Detected**
  Observations with unknown Nondetection (Censor) Variable values are assumed to be nondetects (censored).

- **Detected**
  Observations with unknown Nondetection (Censor) Variable values are assumed to be detected.

- **Missing**
  Observations with unknown Nondetection (Censor) Variable values are assumed to be missing and those rows are omitted from the analysis.

Frequency Variable

Frequency Variable

Specify an optional variable containing the number of observations (cases) represented by each row.

If this variable is left blank, each row of the database is assumed to represent one observation.

Group Variable

Group Variable

An optional categorical (grouping) variable may be specified. If it is used, a separate analysis is conducted for each unique value of this variable. A variable must be entered here to generate log rank test comparisons.

Options

Alpha Level

This is the value to which probability levels are compared for testing hypotheses. Also, one minus alpha is the confidence level used for confidence intervals. For example, if you specify 0.04 here, then 96% confidence limits will be calculated.

A value of .05 is historically the most commonly used. For hypothesis testing, this value represents a 1 in 20 chance of falsely rejecting the null hypothesis. For confidence intervals, this corresponds to a chance of 1 out of 20 of creating an interval that does not contain the true parameter. Now, values other than 0.05 are often recommended or required by journals or institutions. Typical values range from 0.001 to 0.20.

Confidence Limits

This option specifies the method used to estimate the confidence limits. The options are:

- **Linear**
  This is the classical method, which uses Greenwood's estimate of the variance.

- **Log Transform**
  This method uses the logarithmic transformation of Greenwood's variance estimate. It produces better limits than the Linear method and has better small sample properties.

- **ArcSine**
  This method uses the arcsine square-root transformation of Greenwood's variance estimate to produce better limits.

Reports Tab

The following options control which reports are displayed.

Select Reports

Data Summary Section ... Logrank Test Detail

Specify whether to display the indicated reports.

Specific Responses

Specify a list of values for which cumulative proportions are to be calculated. These values are used only if the 'Specific Response Detail' box is checked.

Numbers are separated by blanks or commas. Specify sequences with a colon, putting the increment inside parentheses. For example: 5:25(5) means 5 10 15 20 25.

Use '(10)' alone to specify ten, equal-spaced values between zero and the maximum.

Only positive values may be entered here.

Quantiles

Specify a list of quantiles (percentiles) for which the estimated response is to be calculated. These values are used only if the 'Quantiles of Responses' box is checked.

Numbers are separated by blanks or commas in this list. Specify sequences with a colon, putting the increment inside parentheses. For example: 5:25(5) means 5 10 15 20 25 and 1:5(2),10:20(2) means 1 3 5 10 12 14 16 18 20.

All values in the list must be between 0 and 100.

Report Options

Precision

Specify the precision of numbers in the report. A single-precision number will show seven-place accuracy, while a double-precision number will show thirteen-place accuracy. Note that the reports are formatted for single precision. If you select double precision, some numbers may run into others. Also note that all calculations are performed in double precision regardless of which option you select here. Single precision is for reporting purposes only.

Variable Names

This option lets you select whether to display only variable names, variable labels, or both.

Value Labels

This option lets you select whether to display only values, only value labels, or both for values of the group variable. Use this option if you want to automatically attach labels to the values of the group variable (such as 1=Male, 2=Female, etc.). See the section on specifying *Value Labels* elsewhere in this manual.

Report Options – Decimal Places

Response ... Chi-Square Decimals

This option specifies the number of decimal places shown on reported values.

EDF Plots Tab

The following options control the EDF plots that are displayed.

Select Plots

EDF Plot

This chart is controlled by three form objects:

1. A checkbox to indicate whether the chart is displayed.
2. A format button used to call up the plot format window (see EDF Plot Format Window Options below for more chart formatting details).
3. A second checkbox used to indicate whether the chart can be edited during the run..

Select Plots – Plots Displayed

Individual-Group Plots

When checked, this option specifies that a separate chart of each designated type is displayed.

Combined Plot

When checked, this option specifies that a chart combining all groups is to be displayed.

Plot Options – Plot Arrangement

Two Plots Per Line

When unchecked, one large plot is displayed per line. When checked, two smaller plots are displayed per line.

Storage Tab

These options let you specify if, and where on the database, various statistics are stored.

Warning: If statistics are stored into columns which already contain data, any data in these columns is replaced by the new statistics data. Be careful not to specify variables that contain important data.

Data Storage Options

Storage Option

This option controls whether the values indicated below are stored on the database when the procedure is run.

- **Do not store data**
  No data are stored even if they are checked.

- **Store in empty columns only**
  The values are stored in empty columns only. Columns containing data are not used for data storage, so no data can be lost.

- **Store in designated columns**
  Beginning at the *First Storage Variable*, the values are stored in this column and those to the right. If a column contains data, the data are replaced by the storage values. Care must be used with this option because it cannot be undone.

Store First Variable In

The first item is stored in this variable. Each additional item that is checked is stored in the variables immediately to the right of this variable.

Leave this value blank if you want the data storage to begin in the first blank column on the right-hand side of the data.

Warning: Any existing data in these variables is automatically replaced.

Data Storage Options – Select Items to Store

Response Group ... UCL of P(R)

Indicate whether to store these values, beginning at the variable indicated by the *Store First Variable In* option.

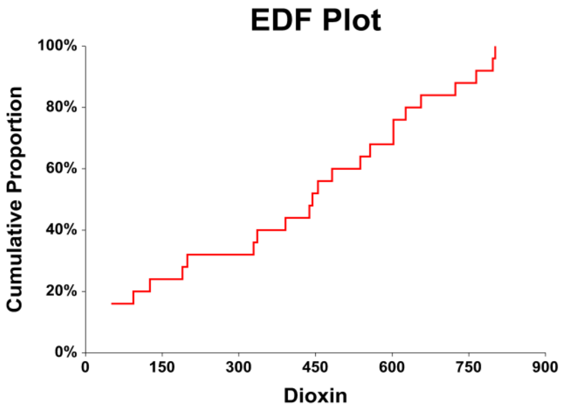
EDF Plot Format Window Options

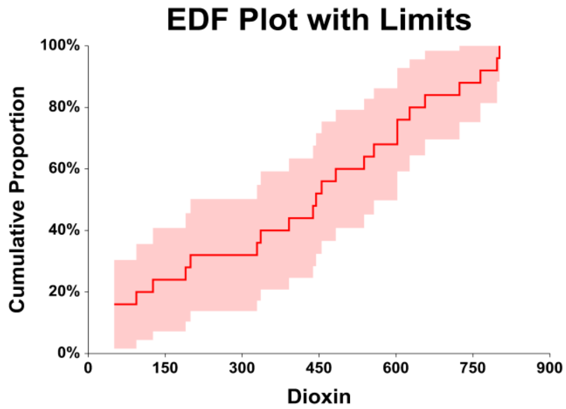
This section describes the specific options available on the EDF Plot Format window, which is displayed when the EDF Plot Format button is clicked. Common options, such as axes, labels, legends, and titles are documented in the Graphics Components chapter.

EDF Plot Tab

EDF Line Section

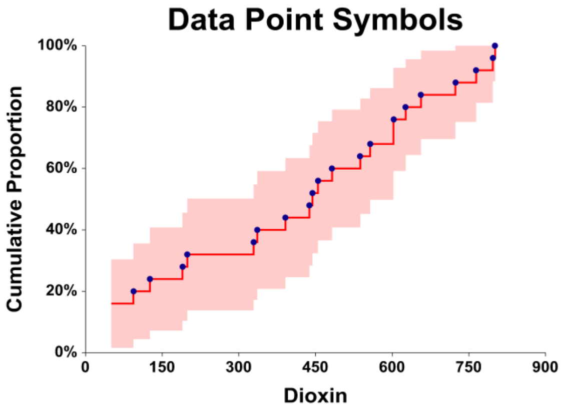
You can modify the attributes of the EDF line using the options in this section.





Symbols Section

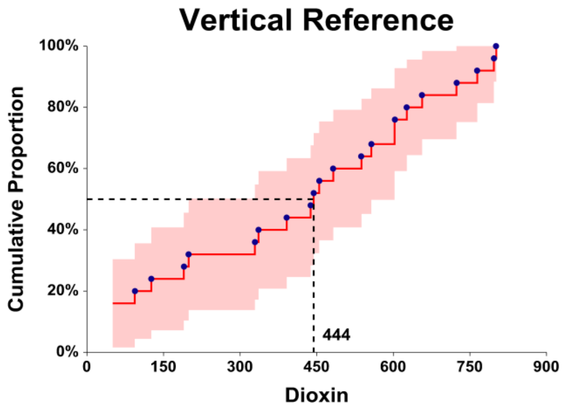
You can modify the attributes of the EDF line using the options in this section.

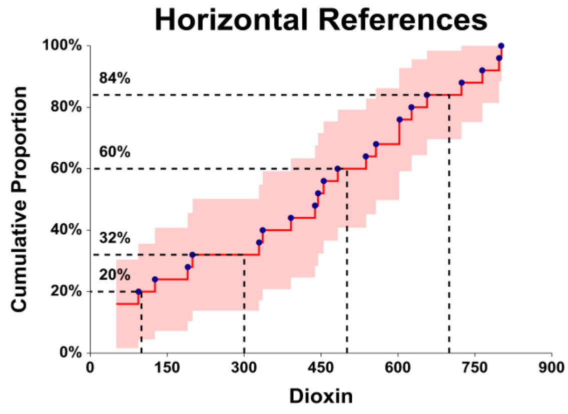


Reference Lines Tab

Lines from [Vertical] / [Horizontal] Axis Sections

You can modify the attributes of the EDF line using the options in this section.





Titles, Legend, Numeric Axis, Group Axis, Grid Lines, and Background Tabs

Details on setting the options in these tabs are given in the Graphics Components chapter.

Example 1 – Analysis of Data with Nondetects

This section presents an example of how to analyze a typical set of nondetects data. Twenty-five air quality locations were randomly chosen to determine dioxin concentration (fg/cubic meter). The lower detection limit of the measurement instrument is 50 fg/cubic meter. Four of the 25 concentrations were not detected, and thus, are known only to be less than 50.

The data used are recorded in the Dioxin dataset.

You may follow along here by making the appropriate entries or load the completed template **Example 1** by clicking on Open Example Template from the File menu of the Nondetects-Data Group Comparison window.

1 Open the Dioxin dataset.

- From the File menu of the NCSS Data window, select **Open Example Data**.
- Click on the file **Dioxin.NCSS**.
- Click **Open**.

2 Open the Nondetects Analysis window.

- Using the Analysis menu or the Procedure Navigator, find and select the **Nondetects-Data Group Comparison** procedure.
- On the menus, select **File**, then **New Template**. This will fill the procedure with the default template.

3 Specify the variables.

- On the Nondetects Analysis window, select the **Variables tab**.
- Set the **Response Variable** to **Dioxin**.

- Set the **Nondetection (Censor) Variable** to **DNondet**.
- Set **Detected** to **0**.
- Set **Not Detected** to **1**.

4 Specify the reports.

- Select the **Reports tab**.
- Set the **Specific Responses** box to **100:500(100)**.

5 Run the procedure.

- From the Run menu, select **Run Procedure**. Alternatively, just click the green Run button.

Data Summary Section

Data Summary Section

Type	Rows	Count	Minimum	Maximum
Detected	21	21	94	801
Not Detected	4	4	50	50
Total	25	25	50	801

Data Summary Section: Response Quartiles

Quartile	Estimate	Lower 95.0% C.L.	Upper 95.0% C.L.
First (Q1)	190.000	50.000	438.000
Median (Q2)	444.000	199.000	603.000
Third (Q3)	603.000	455.000	724.000

This report displays a summary of the amount of data that were analyzed and the three quartiles. Scan this report to determine if there were any obvious data errors by double checking the counts and the minimum and maximum responses.

Specific Response Detail: Estimated Cumulative Proportion

Response (R)	Cumulative Proportion P(R)	Standard Error of P(R)	Lower 95.0% C.L. for P(R)	Upper 95.0% C.L. for P(R)	Cum. Count
100.000	0.2000	0.0800	0.0432	0.3568	5
200.000	0.3200	0.0933	0.1371	0.5029	8
300.000	0.3200	0.0933	0.1371	0.5029	8
400.000	0.4400	0.0993	0.2454	0.6346	11
500.000	0.6000	0.0980	0.4080	0.7920	15

This report displays the Kaplan-Meier cumulative proportions at the specified responses. The standard error and confidence limits are also shown.

Response (R)

This is the specific response being reported on this line. The response values were specified in the Specific Responses box under the Reports tab.

Cumulative Proportion P(R)

This is the estimated proportion of responses less than the specified response (R).

Standard Error of P(R)

This is the estimated standard error, the square root of the variance estimate given by Greenwood's formula.

Lower and Upper Confidence Limits for S(T)

The lower and upper confidence limits provide a pointwise confidence interval for the cumulative proportion at each response. These limits are constructed so that the probability that the true proportion lies between them is $1-\alpha$.

Three difference confidence intervals are available. All three confidence intervals perform similarly for large samples. The linear (Greenwood) interval is the most commonly used. However, the log-transformed and the arcsine-square intervals behave better in small to moderate samples, so they are recommended. The formulas for these limits are given in the Kaplan-Meier Survival Curves chapter and are not repeated here.

Cumulative Count

This value is the number of less than or equal to the specified response (R).

Quantiles of Responses

Proportion of Response	Estimated Quantile	Lower 95.0% C.L. Quantile	Upper 95.0% C.L. Quantile
0.0500		50.000	126.000
0.1000		50.000	190.000
0.1500		50.000	329.000
0.2000	126.000	50.000	336.000
0.2500	190.000	50.000	438.000
0.3000	199.000	50.000	444.000
0.3500	329.000	94.000	455.000
0.4000	391.000	126.000	482.000
0.4500	438.000	190.000	537.000
0.5000	444.000	199.000	603.000
0.5500	455.000	336.000	603.000
0.6000	537.000	391.000	626.000
0.6500	557.000	438.000	656.000
0.7000	603.000	444.000	724.000
0.7500	603.000	455.000	724.000
0.8000	656.000	537.000	764.000
0.8500	724.000	557.000	797.000
0.9000	764.000	603.000	801.000
0.9500	797.000	626.000	801.000

This report displays the estimated quantiles for various response proportions. For example, it gives the median response if it can be estimated.

Proportion of Response

This is the response proportion that is reported on this line. The proportion values were specified in the Quantiles box under the Reports tab.

Estimated Quantile

This is the response value corresponding to the response proportion. For example, this table estimates that 65% of the concentrations are less than or equal to 557 fg/m^3.

Lower and Upper Confidence Limits on Quantiles

These values provide a pointwise $100(1-\alpha)\%$ confidence interval for the estimated quantiles. For example, if the proportion of response 0.50, this provides a confidence interval for the median survival time.

Three methods are available for calculating these confidence limits. The method is designated under the Variables tab in the Confidence Limits box. The formulas for these confidence limits are given in the Kaplan-Meier Survival Curves chapter and are not repeated here.

Because of censoring, estimates and confidence limits are not available for all response proportions.

Response Detail

Response (R)	Cumulative Proportion P(R)	Standard Error of P(R)	Lower 95.0% C.L. for P(R)	Upper 95.0% C.L. for P(R)	Cum. Count	Count
<50.000					4	4
94.000	0.1600	0.0733	0.0163	0.3037	5	1
126.000	0.2000	0.0800	0.0432	0.3568	6	1
190.000	0.2400	0.0854	0.0726	0.4074	7	1
199.000	0.2800	0.0898	0.1040	0.4560	8	1
329.000	0.3200	0.0933	0.1371	0.5029	9	1
336.000	0.3600	0.0960	0.1718	0.5482	10	1
391.000	0.4000	0.0980	0.2080	0.5920	11	1
438.000	0.4400	0.0993	0.2454	0.6346	12	1
444.000	0.4800	0.0999	0.2842	0.6758	13	1
455.000	0.5200	0.0999	0.3242	0.7158	14	1
482.000	0.5600	0.0993	0.3654	0.7546	15	1
537.000	0.6000	0.0980	0.4080	0.7920	16	1
557.000	0.6400	0.0960	0.4518	0.8282	17	1
603.000	0.6800	0.0933	0.4971	0.8629	19	2
626.000	0.7600	0.0854	0.5926	0.9274	20	1
656.000	0.8000	0.0800	0.6432	0.9568	21	1
724.000	0.8400	0.0733	0.6963	0.9837	22	1
764.000	0.8800	0.0650	0.7526	1.0000	23	1
797.000	0.9200	0.0543	0.8137	1.0000	24	1
801.000	0.9600	0.0392	0.8832	1.0000	25	1

This report displays the Kaplan-Meier product-limit distribution values along with confidence limits. The formulas used are given in the Kaplan-Meier Survival Curves chapter.

Response (R)

This is the response being reported on this line. The response are the unique responses that occurred in the data.

Note that observations which are nondetects are marked with a less than sign (<). Estimated proportions are not calculated for nondetects observations.

Cumulative Proportion P(R)

This is the estimated proportion of responses less than the response (R).

Standard Error of S(T)

This is the estimated standard error, the square root of the variance estimate given by Greenwood's formula.

Lower and Upper Confidence Limits for S(T)

The lower and upper confidence limits provide a pointwise confidence interval for the cumulative proportion at each response. These limits are constructed so that the probability that the true proportion lies between them is $1-\alpha$.

Three difference confidence intervals are available. All three confidence intervals perform similarly for large samples. The linear (Greenwood) interval is the most commonly used. However, the log-transformed and the arcsine-square intervals behave better in small to moderate samples, so they are recommended. The formulas for these limits are given in the Kaplan-Meier Survival Curves chapter and are not repeated here.

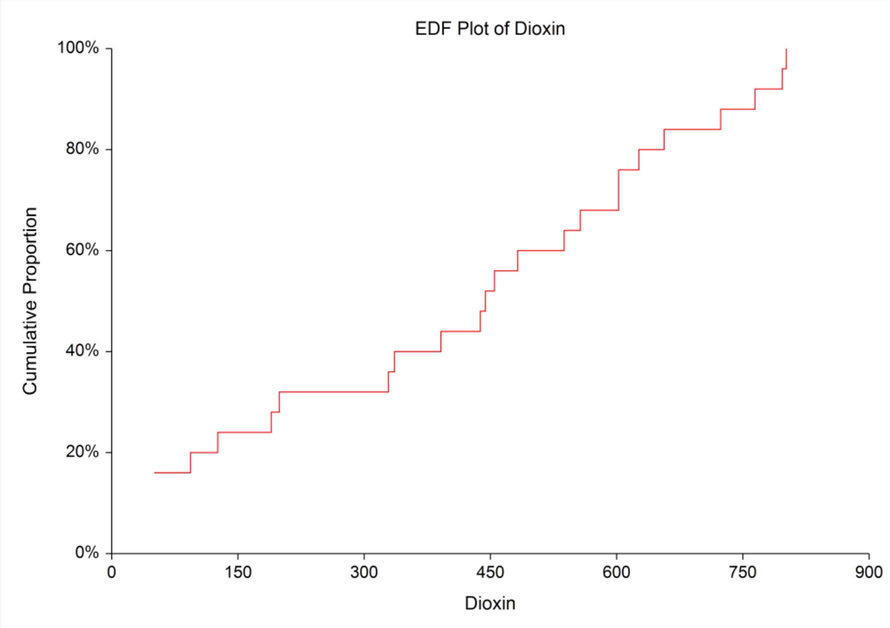
Cumulative Count

This value is the number of less than or equal to the specified response (R).

Count

This is the number of observations with this specific response value.

EDF Plot



This plot shows the empirical distribution function (EDF). If there are several groups, a separate line is drawn for each group.

Example 2 – Group Comparisons with Nondetects

The research purpose of this example is comparing sediment arsenic concentrations for three different regions of a lake. A single sample was taken from each of twenty randomly selected locations of each region. The response is the concentration of arsenic in mg/Kg (dry weight). The instruments used in the study to determine arsenic concentration are unable to detect concentrations below 10 mg/Kg.

The data used are recorded in the variables Arsenic, ANondet, and Region of the Arsenic dataset.

You may follow along here by making the appropriate entries or load the completed template **Example 2** by clicking on Open Example Template from the File menu of the Nondetects-Data Group Comparison window.

1 Open the Arsenic dataset.

- From the File menu of the NCSS Data window, select **Open Example Data**.
- Click on the file **Arsenic.NCSS**.
- Click **Open**.

2 Open the Nondetects Analysis window.

- Using the Analysis menu or the Procedure Navigator, find and select the **Nondetects-Data Group Comparison** procedure.
- On the menus, select **File**, then **New Template**. This will fill the procedure with the default template.

3 Specify the variables.

- On the Nondetects Analysis window, select the **Variables tab**.
- Set the **Response Variable** to **Arsenic**.
- Set the **Nondetection (Censor) Variable** to **ANondet**.
- Set the **Group Variable** to **Region**.

4 Specify the reports.

- On the Nondetects Analysis window, select the **Reports tab**.
- Check the **Logrank Test Summary** box.
- Check the **Logrank Test Detail** box.

5 Run the procedure.

- From the Run menu, select **Run Procedure**. Alternatively, just click the green Run button.

Logrank Tests Section

Hypotheses
H0: Distribution Functions are Equal Among Groups
HA: At Least One Group Distribution Functions Differs

Test Name	Chi-Square	DF	Prob Level	Reject H0 (Alpha = 0.05)
Logrank	26.680	2	0.0000	Yes
Gehan-Wilcoxon	35.265	2	0.0000	Yes
Tarone-Ware	32.241	2	0.0000	Yes
Peto-Peto	35.479	2	0.0000	Yes
Mod. Peto-Peto	35.589	2	0.0000	Yes

Multiple Pairwise Tests Section
Hypotheses
H0: Distribution Functions are Equal
HA: Distribution Functions Differ

Group Pair Tested: 1 vs. 2

Test Name	Chi-Square	DF	Prob Level	Reject H0 (Alpha =0.05)	Bonferroni Adjusted Prob Level	Reject H0 (Alpha =0.05)
Logrank	0.374	1	0.5409	No	1.0000	No
Gehan-Wilcoxon	0.326	1	0.5683	No	1.0000	No
Tarone-Ware	0.389	1	0.5327	No	1.0000	No
Peto-Peto	0.267	1	0.6055	No	1.0000	No
Mod. Peto-Peto	0.265	1	0.6069	No	1.0000	No

Group Pair Tested: 1 vs. 3

Test Name	Chi-Square	DF	Prob Level	Reject H0 (Alpha =0.05)	Bonferroni Adjusted Prob Level	Reject H0 (Alpha =0.05)
Logrank	16.239	1	0.0001	Yes	0.0002	Yes
Gehan-Wilcoxon	19.657	1	0.0000	Yes	0.0000	Yes
Tarone-Ware	18.787	1	0.0000	Yes	0.0000	Yes
Peto-Peto	19.418	1	0.0000	Yes	0.0000	Yes
Mod. Peto-Peto	19.457	1	0.0000	Yes	0.0000	Yes

Group Pair Tested: 2 vs. 3

Test Name	Chi-Square	DF	Prob Level	Reject H0 (Alpha =0.05)	Bonferroni Adjusted Prob Level	Reject H0 (Alpha =0.05)
Logrank	15.978	1	0.0001	Yes	0.0002	Yes
Gehan-Wilcoxon	20.474	1	0.0000	Yes	0.0000	Yes
Tarone-Ware	19.109	1	0.0000	Yes	0.0000	Yes
Peto-Peto	20.391	1	0.0000	Yes	0.0000	Yes
Mod. Peto-Peto	20.453	1	0.0000	Yes	0.0000	Yes

Notes:
The most commonly used test is the Logrank test.

This report gives the results of the five logrank type tests that are provided by this procedure. We strongly suggest that you select the test that will be used before viewing this report. We recommend the Logrank test.

The tests are divided into two groups: overall tests and pairwise tests. The overall tests test for significant differences between groups, but do not indicate which groups are different from each other. The pairwise tests indicate which groups have significantly different distribution functions. Adjusted probability levels should be used to account for multiplicity of tests.

Chi-Square

This is the chi-square value of the test. Each of these tests is approximately distributed as a chi-square in large samples.

DF

This is the degrees of freedom of the chi-square distribution associated with each test. It is one less than the number of groups being compared in a particular test.

Prob Level

This is the significance level of the test. If this value is less than than chosen significance level (often 0.05), the test is significant, indicating evidence of a difference in distribution functions. For pairwise tests the Bonferroni adjusted probability level should be used to account for multiple testing.

Reject H0

This is an indicator based on the comparison of the probability level to the specified alpha. 'Yes' indicates rejection of the null hypothesis (evidence that the true distribution functions are different). 'No' indicates the null hypothesis should not be rejected (not sufficient evidence that the true distribution functions are different).

Bonferroni Adjusted Prob Level

When more than two groups are compared, the number of pairwise comparisons is greater than one. Bonferroni adjusted probability levels account for the multiplicity of hypothesis tests. The Bonferroni adjustment to the probability level is made by multiplying the given probability level by the number of tests that are performed (with a ceiling of 1.0). In this example, three pairwise comparisons are made. Thus, each probability level is multiplied by three. Any adjusted probability level greater than one is set to one. The Bonferroni adjusted probability level for the last two longrank tests in this example appears to be only two times the base probability level. This is due to rounding. If more decimal places are specified, it is seen that the adjusted probability levels are three times the base probability levels.

Logrank Test Detail Section

Logrank Test Detail Section

Group	Z-Value	Standard Error	Standardized Z-Value
1	-7.561	3.398	-2.225
2	-4.484	3.380	-1.327
3	12.044	2.340	5.146

Probability Level was 0.0000

Gehan-Wilcoxon Test Detail Section

Group	Z-Value	Standard Error	Standardized Z-Value
1	-349.000	132.199	-2.640
2	-270.000	132.219	-2.042
3	619.000	104.394	5.929

Probability Level was 0.0000

Tarone-Ware Test Detail Section

Group	Z-Value	Standard Error	Standardized Z-Value
1	-51.277	20.460	-2.506
2	-35.076	20.428	-1.717
3	86.353	15.249	5.663

Probability Level was 0.0000

Peto-Peto Test Detail Section

Group	Z-Value	Standard Error	Standardized Z-Value
1	-5.568	2.114	-2.634
2	-4.453	2.114	-2.106
3	10.021	1.684	5.949

Probability Level was 0.0000

Mod. Peto-Peto Test Detail Section

Group	Z-Value	Standard Error	Standardized Z-Value
1	-5.452	2.065	-2.640
2	-4.377	2.066	-2.119
3	9.830	1.650	5.959

Probability Level was 0.0000

This report gives the details of each of the five logrank tests that are provided by this procedure. We strongly suggest that you select the test that will be used before viewing this report. We recommend that you use the Logrank test.

Group

This is the group reported on this line.

Z-Value

The details of the z-value are given in the Kaplan-Meier Survival Curves chapter and are not repeated here.

Standard Error

This is the standard error of the above z-value. It is used to standardize the z-values.

Standardized Z-Value

The standardized z-value is created by dividing the z-value by its standard error. This provides an index number that will usually very between -3 and 3. Extreme values represent groups that are quite different from the typical group, at least at some response values.

Example 3 – Validation of Summary Statistics using Helsel (2005)

This section presents validation of nondetects analysis summary statistics. Helsel (2005) presents an example on pages 103-113 involving lead concentrations. These data are contained in the Lead dataset.

On page 108, Helsel (2005) finds the median to be 1 – 0.984483 = 0.015517. The first and third quartiles are 1 – 0.985714 = 0.014286 and 1 – 0.975472 = 0.024528, respectively. The cumulative proportion for a lead concentration of 0.034 is 0.777778. The (B-C Sign) 95% confidence interval for the median lead concentration is presented on page 112 as (0.014, 0.019).

You may follow along here by making the appropriate entries or load the completed template **Example 3** by clicking on Open Example Template from the File menu of the Nondetects-Data Group Comparison window.

1 Open the Lead dataset.

- From the File menu of the NCSS Data window, select **Open Example Data**.
- Click on the file **Lead.NCSS**.
- Click **Open**.

2 Open the Nondetects Analysis window.

- Using the Analysis menu or the Procedure Navigator, find and select the **Nondetects-Data Group Comparison** procedure.
- On the menus, select **File**, then **New Template**. This will fill the procedure with the default template.

3 Specify the variables.

- On the Nondetects Analysis window, select the **Variables tab**.
- Set the **Response Variable** to **Lead**.
- Set the **Nondetection (Censor) Variable** to **LNondet**.

4 Specify the reports.

- On the Nondetects Analysis window, select the **Reports tab**.
- Uncheck all reports except the **Data Summary Section** and **Response Detail**.
- Change **Decimal Places - Response** to **6**.

5 Run the procedure.

- From the Run menu, select **Run Procedure**. Alternatively, just click the green Run button.

Output

Data Summary Section

Type	Rows	Count	Minimum	Maximum
Detected	12	12	1.372549E-02	0.2689655
Not Detected	15	15	0.02	0.02
Total	27	27	1.372549E-02	0.2689655

Data Summary Section: Response Quartiles

Quartile	Estimate	Lower 95.0% C.L.	Upper 95.0% C.L.
First (Q1)	**0.014286**	0.013725	0.018644
Median (Q2)	**0.015517**	**0.014286**	**0.018644**
Third (Q3)	**0.024528**	0.015517	0.106061

Response Detail

Response (R)	Cumulative Proportion P(R)	Standard Error of P(R)	Lower 95.0% C.L. for P(R)	Upper 95.0% C.L. for P(R)	Cum. Count	Count
0.013725	0.0000				1	1
0.014286	0.1759	0.1539	0.0000	0.4776	2	1
0.015517	0.3519	0.1813	0.0000	0.7073	3	1
0.018644	0.5278	0.1660	0.2024	0.8531	4	1
<0.020000					19	15
0.023529	0.7037	0.0879	0.5315	0.8759	20	1
0.024528	0.7407	0.0843	0.5754	0.9060	21	1
0.033962	**0.7778**	0.0800	0.6210	0.9346	22	1
0.049153	0.8148	0.0748	0.6683	0.9613	23	1
0.106061	0.8519	0.0684	0.7179	0.9858	24	1
0.174074	0.8889	0.0605	0.7703	1.0000	25	1
0.177049	0.9259	0.0504	0.8271	1.0000	26	1
0.268966	0.9630	0.0363	0.8917	1.0000	27	1

You can check this table to see that the results are the same as those of Helsel (2005).

Example 4 – Validation of Group Comparison Statistics using Helsel (2005)

This section presents validation of the group comparison statistics. Helsel (2005) presents an example of results for comparing concentrations among three groups. These data are contained in the Concentration dataset.

The results for the overall test for determining difference in concentration patterns across groups is found on page 180. The log rank test results in a chi-square statistic of 16.2794 with probability level 0.000. The Gehan (Wilcoxon) test gives a chi-square statistic of 16.0761 with probability level 0.000. The results of the individual group comparison Gehan (Wilcoxon) tests are given on page 181. For comparing the low group to the medium group, the chi-square value is 0.68890 with probability level 0.407. For comparing the low group to the high group, the chi-square value is 7.09906 with probability level 0.008. For comparing the medium group to the high group, the chi-square value is 11.5275 with probability level 0.001.

These data can be run in this procedure to see that ***NCSS*** gets the same results. You may follow along here by making the appropriate entries or load the completed template **Example 4** by clicking on Open Example Template from the File menu of the Nondetects-Data Group Comparison window.

1 Open the Concentration dataset.

- From the File menu of the NCSS Data window, select **Open Example Data**.
- Click on the file **Concentration.NCSS**.
- Click **Open**.

2 Open the Nondetects Analysis window.

- Using the Analysis menu or the Procedure Navigator, find and select the **Nondetects-Data Group Comparison** procedure.
- On the menus, select **File**, then **New Template**. This will fill the procedure with the default template.

3 Specify the variables.

- On the Nondetects Analysis window, select the **Variables tab**.
- Set the **Response Variable** to **Conc**.
- Set the **Nondetection (Censor) Variable** to **CNondet**.
- Set the **Group Variable** to **Group**.

4 Specify the reports.

- On the Nondetects Analysis window, select the **Reports tab**.
- Uncheck all reports except the **Logrank Test Summary** report.

5 Run the procedure.

- From the Run menu, select **Run Procedure**. Alternatively, just click the green Run button.

Output

Logrank Tests Section
Hypotheses
H0: Distribution Functions are Equal Among Groups
HA: At Least One Group Distribution Functions Differs

Test Name	Chi-Square	DF	Prob Level	Reject H0 (Alpha = 0.05)
Logrank	**16.280**	**2**	**0.0003**	**Yes**
Gehan-Wilcoxon	**16.076**	**2**	**0.0003**	**Yes**
Tarone-Ware	16.669	2	0.0002	Yes
Peto-Peto	16.359	2	0.0003	Yes
Mod. Peto-Peto	16.369	2	0.0003	Yes

Multiple Pairwise Tests Section
Hypotheses
H0: Distribution Functions are Equal
HA: Distribution Functions Differ

Group Pair Tested: High vs. Low

Test Name	Chi-Square	DF	Prob Level	Reject H0 (Alpha =0.05)	Bonferroni Adjusted Prob Level	Reject H0 (Alpha =0.05)
Logrank	**7.360**	**1**	**0.0067**	**Yes**	**0.0200**	**Yes**
Gehan-Wilcoxon	**7.099**	**1**	**0.0077**	**Yes**	**0.0231**	**Yes**
Tarone-Ware	7.282	1	0.0070	Yes	0.0209	Yes
Peto-Peto	7.385	1	0.0066	Yes	0.0197	Yes
Mod. Peto-Peto	7.378	1	0.0066	Yes	0.0198	Yes

Group Pair Tested: High vs. Medium

Test Name	Chi-Square	DF	Prob Level	Reject H0 (Alpha =0.05)	Bonferroni Adjusted Prob Level	Reject H0 (Alpha =0.05)
Logrank	11.398	1	0.0007	Yes	0.0022	Yes
Gehan-Wilcoxon	**11.528**	**1**	**0.0007**	**Yes**	**0.0021**	**Yes**
Tarone-Ware	11.931	1	0.0006	Yes	0.0017	Yes
Peto-Peto	11.454	1	0.0007	Yes	0.0021	Yes
Mod. Peto-Peto	11.470	1	0.0007	Yes	0.0021	Yes

Group Pair Tested: Low vs. Medium

Test Name	Chi-Square	DF	Prob Level	Reject H0 (Alpha =0.05)	Bonferroni Adjusted Prob Level	Reject H0 (Alpha =0.05)
Logrank	1.125	1	0.2888	No	0.8663	No
Gehan-Wilcoxon	**0.689**	**1**	**0.4065**	**No**	**1.0000**	**No**
Tarone-Ware	0.796	1	0.3723	No	1.0000	No
Peto-Peto	1.109	1	0.2923	No	0.8769	No
Mod. Peto-Peto	1.092	1	0.2961	No	0.8884	No

Notes:
The most commonly used test is the Logrank test.

You can check this table to see that the results are the same as those of Helsel (2005).