Creating a Custom Calibration

1 Introduction

The Distell Fatmeter reports the fat content in fish, and to do this it takes a measurement using a microwave sensor. The sensor transmits a very low power, high frequency signal into the sample being measured then analyses the response. The sensor response is affected by the mix of fat, water and body solids in the sample.

The body solids component for a given species is generally quite constant, and the main variables are fat and water content. The Fatmeter can report the fat content with good accuracy if it knows how the sample's fat and water content are related, and that relationship is what we will explore in this document.

Note that this document is based around measuring fish, but the same principles apply for our Meat Fatmeter. Also this applies to naturally-occurring fish and meat, rather than man-made products like hamburger.

1.1 Fat content

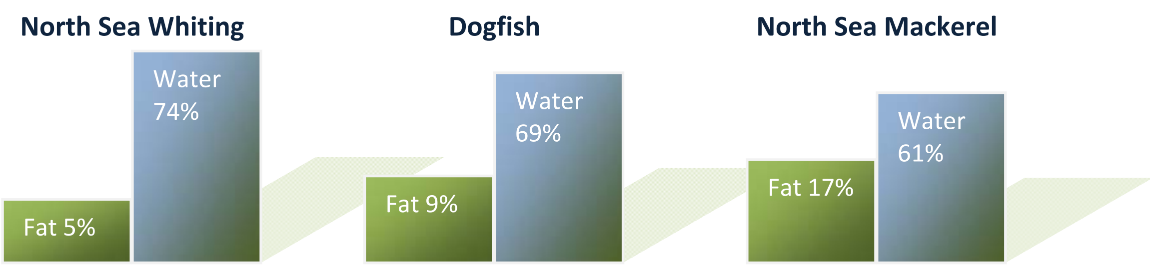
What do we mean by 'fat content'? Different Fatmeter users have different areas of interest and that means that sometimes they don't want the fat content of the whole fish. Different target measurements include:

- The fat content of the entire fish, including skin, fins, bones, etc.;
- The fat content of the fish fillets;
- The fat content of a specific section of the fish.

When we talk about the fat content of a sample, therefore, it could mean one of these three different measurements, or other measurements that are used by different organisations around the world.

1.2 Ratio of Fat to Water

Here are some examples of how the water and fat content can vary with different fish species:



Since the ratio of fat to water can change for different fish, the Fatmeter needs to know how to relate the fat content to the measured water content. The relationship is called a **calibration**.

A Fatmeter calibration represents the relationship between the meter's sensor measurements and the fat content of the sample.

2 Calibrations

2.1 Example calibration

An example of a calibration would be J.MACKEREL-1. This is our Jack Mackerel calibration, and it represents the fat content of two trimmed fillets without skin. You can find out more about this specific calibration at http://www.distell.com/downloads/charts/JMackerel1.pdf.

This calibration provides a mapping from the range of Fatmeter sensor measurements to actual fat percentages. The calibration was created by taking a range of actual fish samples and recording the sensor measurements. The samples were then sent for laboratory analysis and the fat percentages were mapped to the sensor measurements. In this way the Fatmeter can, when the J.MACKEREL-1 calibration is selected, give a fat percentage reading that represents the fat content of the fillets, as determined by laboratory analysis.

2.2 Different calibrations for different target measurements

In section 1.1, "Fat content", we showed different ways to think of the fat content of a fish. The J.MACKEREL-1 calibration represents the fat content of the trimmed fillets, but there is another Jack Mackerel calibration, J.MACKEREL-2, that represents the fat content of the whole fish including head, tail, fins, skin, roe and flesh.

In this way we can have multiple calibrations for a single species. This allows us to accommodate some of the factors that affect the measured fat content of a fish, such as:

- Seasonal factors;
- Processing methods;
- Specific sections of the fish

A detailed list of the fish calibrations available is on the Distell website, www.distell.com.

2.3 What is a custom calibration?

A custom calibration is a calibration where the end-user supplies the calibration data, rather than one that has already been developed by Distell.

There are various reasons why a custom calibration might be useful:

- The target fish species does not have an existing calibration;
- The fish will be processed in a way that is not covered by an existing calibration;
- A different laboratory method is being used, so a different range of results is needed.

3 Gathering sample data

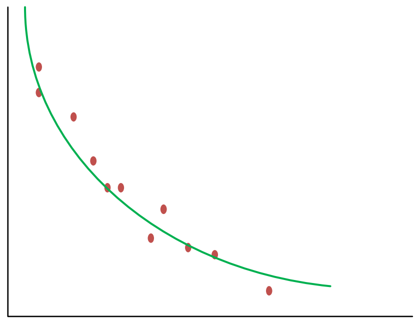
3.1 The RESEARCH-1 calibration

Every Distell meter contains the RESEARCH-1 calibration. This calibration is there to help you create a custom calibration. When measurements are taken using RESEARCH-1, the values shown don't actually show the fat percentage of the sample; instead they give a representation of the sensor measurement for the sample.

When you set out to create a custom calibration, use RESEARCH-1 for measurements on fish. This will give you the best accuracy.

3.2 The theory of a custom calibration

This is a simplified view of the principle of a custom calibration.



When the Fatmeter is used on a piece of fish then there is a specific sensor measurement, called the **reference value**. A custom calibration allows you to relate that sensor measurement to a fat measurement, called the **analysis value**.

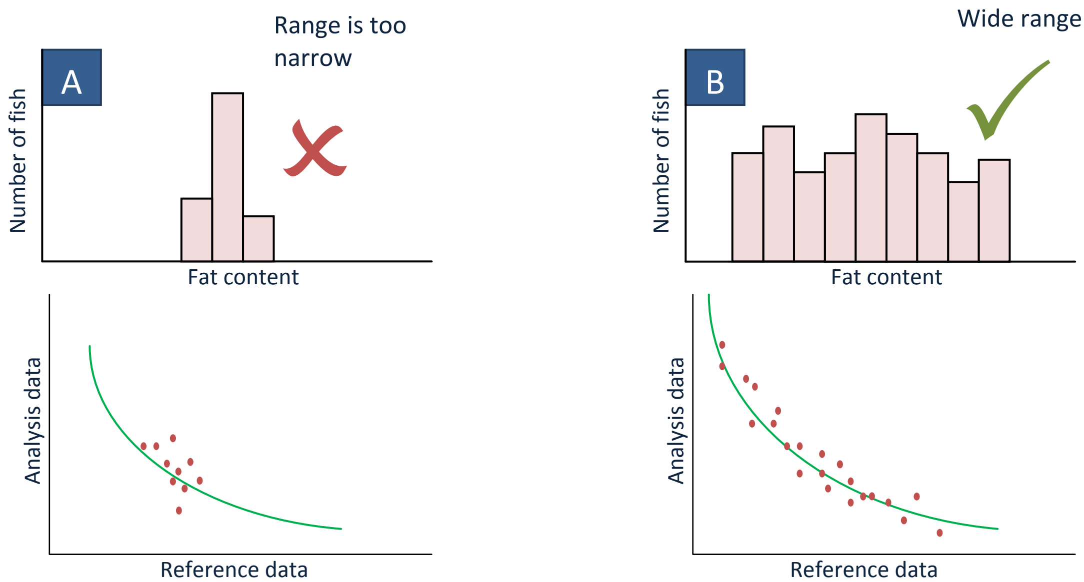
When there is more than one pair of reference and analysis values then we can work out a best-fit approximation to cover the whole range of reference values. We can then take any sensor measurement (reference value) and find the corresponding fat content (analysis value).

The quality of the custom calibration is (partly) based on the quality of the best-fit approximation. This, in turn, depends on the number of data points that are available. **More data is better.** If you have only a few data points then the calibration will not be reliable.

3.3 How to choose the sample fish

Every custom calibration begins with taking measurements on a set of sample fish. It is **very important** to get a wide range of fat contents in the sample fish.

These graphs show two different situations. Graph 'A' shows a sample where all the fish have a similar fat content. Graph 'B' shows a sample where the fish cover a wide range of fat content from low to high.



Remember, a calibration is the relationship between sensor measurements and fat content across the whole range of possible fat content values for the target fish.

In graph 'A', where the fish have similar fat content, then the custom calibration will only be able to give accurate readings when used on fish in the middle range of fat content. When it is used on fish with high or low fat contents, i.e. fish outside the range represented by the sample, then it will not be able to give accurate data because it has no data points in those areas.

3.4 How many fish make a calibration?

First, and this repeats the point made above, if the sample fish do not cover the full range of fat content then you will not get a good calibration.

If the fish *do* cover the full range of fat content then you should have a minimum of 10 fish to get a basic calibration. To get a good quality calibration you should have at least 30 fish samples.

The more fish samples you can use, the more accurate your calibration will be. This is because there are always small variations in the course of the sampling (e.g. the position of the sensor on the fish, the distribution of fat in the fish, laboratory technique variations, etc.) Having many samples will reduce the error introduced by those variations.

3.5 Gathering data – the first step in creating a custom calibration

Once you have selected a set of sample fish you can start taking measurements with the Fatmeter. Each sample fish should be uniquely identified (e.g. by storing it in a sealed, marked container) and Fatmeter reading should be recorded on paper alongside the identity of the fish that it came from.

Remember: each measurement on fish should be done following the guidelines in the Fatmeter User Manual, so that each fish is represented by an average value of multiple readings.

Once all the fish have been measured with the Fatmeter the fish can go on to the next stage.

4 Laboratory analysis

The laboratory analysis should be performed on the fish according to what your custom calibration will represent.

For example:

- If your custom calibration will represent the whole fish then the laboratory analysis should be performed on the whole fish.
- If your custom calibration will represent the fat content of fillets in brine then the laboratory analysis should be performed on fillets in brine.

The laboratory process is not perfect, and you should work with your chosen laboratory to ensure that accurate results are obtained.

Ensure that the identity of the fish is recorded along with the laboratory analysis, because you need to be able to connect the original Fatmeter reading with the laboratory analysis figure.

5 Creating the custom calibration

5.1 Requirements

To create a custom calibration you will need:

- The Distell Data Management System software;
- The calibration file (with a .DCF extension) containing the reference calibration (normally RESEARCH-1) for the meter used to take the measurements (this was supplied with your meter, but we can send a copy by email if required);
- The reference data (recorded from the Fatmeter)
- The analysis data (recorded from the laboratory analysis).

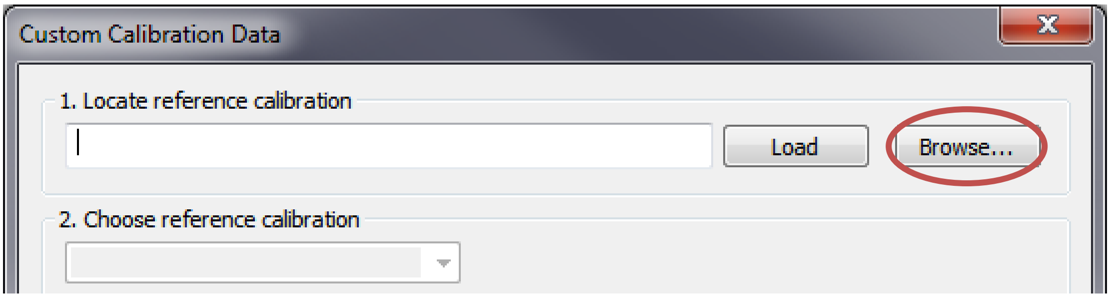
5.2 Creating the calibration

Launch the Data Management System and click on ‘Create custom calibration’ under the File menu.

The Custom Calibration Data window will open. The first step is to load in the .DCF file for the meter used to take the measurements. This should be on the CD that was supplied with the meter.

5.2.1 Loading the reference .DCF file

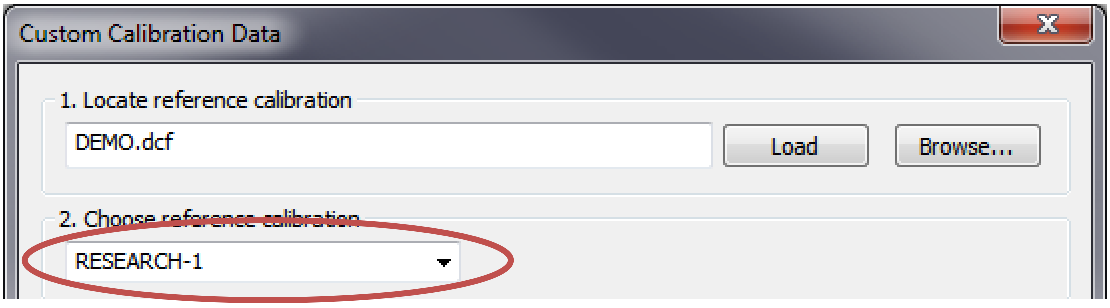
First, click the ‘Browse...’ button and find the .DCF file or simply type in the filename.



Then click the 'Load' button to load the file into the DMS.

5.2.2 Choose the reference calibration

Select the calibration used to make the Fatmeter measurements from the drop-down list. This should normally be RESEARCH-1.



5.2.3 Enter the reference and analysis data

Enter each pair of reference (Fatmeter) and analysis (laboratory) data items in the table.

As the data is entered the best-fit graph will gradually build up and you will be able to see, visually, the spread of data points.

If you have a large amount of data to enter, you may find it easier to create the data table in a spreadsheet then save it as a .CSV file. This .CSV file can then be imported using the 'Import CSV' button. The file should be formatted such that the Reference data is in the first column and the Analysis data is in the second.

You can change the type of best-fit curve that is used, but normally this is best left as 'Exponential'.

5.2.4 Enter the range limits

The range limits are the highest and lowest values that your custom calibration can show. For example, if you are creating a custom calibration for a species that will never have more than 20% fat then you can set 20.0 as the maximum limit. Or, if your calibration should read up to 50% fat then you can set 50.0 as the maximum.

Readings outside of this range will be shown as 'Out of range' on the Fatmeter.

The DMS will automatically set range limits based on the data that you enter, but you can override the automatic values.

5.2.5 Enter a calibration name

The calibration name will appear on the Fatmeter when the calibration is selected. It is limited to a maximum of 12 letters and numbers. You should ensure that the calibration name is different to any other calibration that you have in the meter.

5.2.6 Select a 'grouping method'

To select the correct option here, check your Fatmeter menu options.

- If you have separate Product and Research menus for selecting calibrations then choose 'Separate'. This will be the case on newer meters, or meters that have recently been upgraded.
- If you have a single calibration selection menu that combines all the calibrations (research and product) then select Combined. This is only the case on older meters.

5.2.7 Select a research slot

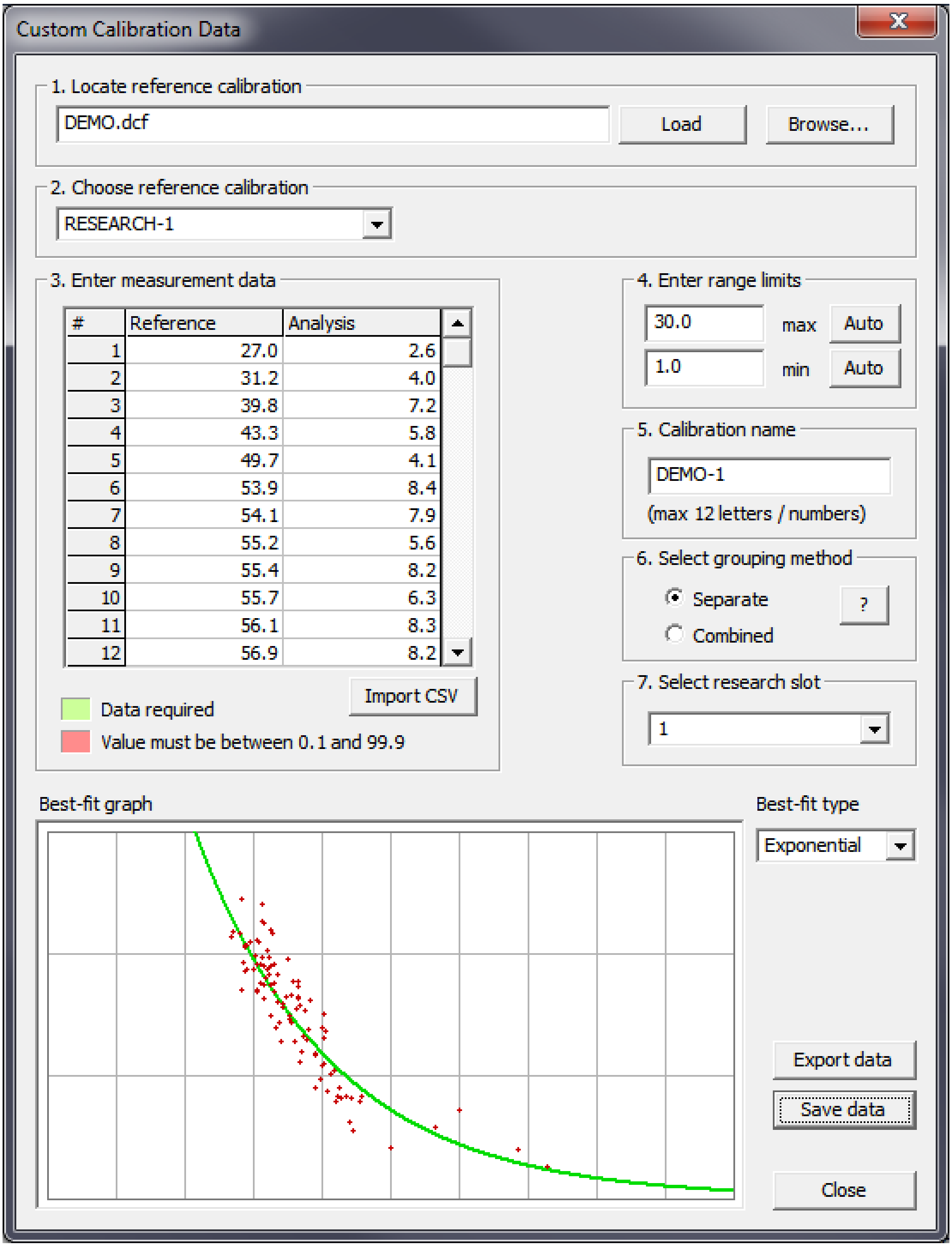
The Fatmeter has a bank of calibration slots for research purposes, beginning with Research-1. Your meter was supplied with a guide to which slots hold which calibrations. This option decides which slot your custom calibration should be loaded into.

Note that it is your responsibility to make sure that you don't overwrite an existing calibration. You should, therefore, keep a record of which slots are assigned to custom calibrations.

Note also that the DMS can create a custom calibration for a high numbered slot, e.g. slot 9, that your meter does not have access to. You can only access the slots listed on the guide, so you should ensure that you custom calibration uses one of those slots.

5.2.8 Save the custom calibration

Click on 'Save data' to save the custom calibration as a .DCF file. This file can be uploaded to your meter using the DMS. Check the meter's user manual for details on this procedure.



5.3 Using the calibration in a different meter

The process described here covers creating a custom calibration for the same meter that was used to take the measurements on the sample fish.

If you want to use the custom calibration in a different meter then you can do so without taking new measurements. Instead, you should take the following steps:

- In section 5.2.1, "Loading the reference .DCF file", load the .DCF file for the meter that will use the custom calibration, rather than the meter that was used to take the measurements.
- In sections 5.2.6 and 5.2.7 refer to the guide for the meter that will use the custom calibration, rather than the meter that was used to take the measurements.

- When you save the custom calibration you should include the serial number of the target meter in the filename. This will make it easier to keep track of which .DCF file goes with each meter.

Each Fatmeter has tiny variations in sensor characteristics when compared to another meter. When a Fatmeter is prepared by Distell these variations are removed by preparing each meter's calibrations individually.

In the same way, each custom calibration is unique to an individual meter, specifically the meter whose reference calibration was selected in step 5.2.1. If you create a custom calibration for meter X but load it into meter Y then it will not give correct results.

In summary, you need to create a new .DCF file for each Fatmeter but you can use the same reference and analysis data for each one.

6 Measuring processed food

At the start of this document we said that the custom calibration process applied only to natural product, rather than man-made product. We will take a moment to explain what this means.

When natural fish is processed into a man-made product the ratio of fat to water will usually change. Curing, smoking and brining, for example, will remove some water from the fish, and the amount of water removed depends on how long the process lasts.

It is still possible to use the Fatmeter on processed food but only if the processing method is identical for each batch of fish.

6.1 An example: Matjes Herring

Matjes herring is a Dutch speciality, where herring fillets are cured in salt then stored in brine. Even though it has been heavily processed, and the water to fat ratio has changed due to curing, we can still create a custom calibration.

We will consider two different options for this:

6.1.1 Option 1

In this example the reference data is gathered on the processed fish, and then laboratory analysis is performed as usual. Following the steps in this document you would then have a custom calibration that represents the fat content of this producer's herring, processed in exactly the way that the sample was processed, when measured on processed product (normally minced product rather than brined fillets).

This allows the producer to assess the fat content of the processed product directly.

6.1.2 Option 2

This example involves gathering reference data from the raw, unprocessed herring. The fish is then processed by the producer's standard method and sent for laboratory analysis as normal. A custom calibration can now be developed, and the calibration represents the fat content of this producer's herring, processed in exactly the way that the sample was processed, when measured on raw fish.

This allows the producer to predict the fat content of the final product by taking measurements on the raw fish before processing.

6.1.3 The impact of processing

The main point in these examples is that, in both cases, the custom calibration represents the product *after* processing. It is vital to understand that the custom calibration will only be valid if the fish is processed *in exactly the same way every time*.

If, for example, the fish are cured for an extra few days, or the brine mixture changes, or the fish are allowed to dry, or if any other part of the process changes then the custom calibration will not be valid. The calibration was created to represent a specific process, but now the process has changed.

6.2 A more useful application

We know that variations in fish processing can cause the Fatmeter readings to change. Many Fatmeter users have found this helpful in checking the day-to-day consistency of their processing. Since the results from the Fatmeter will change if the process changes, it follows that if the Fatmeter results stay the same (within a margin for error) then the process has not changed.

So the Fatmeter can be used as an assurance of consistency by:

1. Using the Fatmeter to establish a 'normal' reading for the processed product, then
2. Checking that the processed product continues to show the same 'normal' reading.

If the processed product gives a different reading then that can indicate that some part of the process has changed, and appropriate checks can be carried out to find out what has happened.

6.3 Summary

Natural fish are generally very predictable in terms of the mix of fat, water and body solids, which is why one calibration can work on a whole species. Once processing is introduced, however, the mix changes and many variables are introduced. This does not mean the Fatmeter can't be used on processed food, but it is important to be aware of how changes in the process will affect the accuracy of a calibration.

The Fatmeter can, however, give a high level of confidence in product consistency simply because the measurements can be checked against a standard from one day to the next.