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Introduction

Humpback whale researchers from around the world have been using photo-identification techniques to study individual humpback whales for numerous decades now, resulting in many thousands of photographs of the underside tail flukes of these whales being collected. However, a major problem arises for researchers using this method over time, as the number of comparisons required to search for matching flukes in a catalogue grows exponentially with increasing catalogue size. Clearly a computerised system is required to make this process more efficient, especially for large catalogues.

*Fluke Matcher* is a system designed to improve and reduce the time required for matching fluke photographs. It is not a fully independent computerised matching system, but instead acts as a support system to make manual matching more efficient. The program utilises the unique characteristics of humpback whale flukes and stores information in a database, enabling it to be quickly retrieved to achieve rapid matching results. When searching for a match within the database, *Fluke Matcher* uses the features of the ‘target fluke’ to rank and re-order the rest of the database from the most likely to the least likely match. The operator then visually compares the ranked images to check for matches to the target fluke.

The development and fundamentals of the *Fluke Matcher* system are outlined in the following publication:


Tests of the system have shown that it is important for operators to have some experience and training in the use of the system before using it for robust matching exercises. This User Manual outlines the procedures for creating fluke databases, entering, saving and searching for flukes, and protocols required for operators to achieve the best results from the *Fluke Matcher* system.
Acknowledgements

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Funding for the development of *Fluke Matcher* was provided by research grants from the Australian Government, initially through Environment Australia and the Australian Centre for Applied Marine Mammal Science, and more recently through the Australian Marine Mammal Centre.
Preparation of images

Before entering fluke images into Fluke Matcher, it is recommended that you crop your images to a 3:2 aspect ratio, so that the fluke fills most of the frame. We also recommend rotating the fluke image before you crop it so that a line drawn between the fluke tips would be horizontal (i.e. parallel to the top of the frame).

![Original image](image1.png) ![Cropped image](image2.png)

Note that if not all of the fluke is shown in the image, it should be cropped with some extra space around it so that you can estimate the position of the missing extremities (i.e. the fluke tips):

![Original image](image3.png) ![Image cropped for Fluke Matcher](image4.png)

Fluke Matcher Databases

Fluke Matcher utilises databases in a number of different ways. When first created, a database is initially classified as an ‘Input database’. New fluke images can only be added to the Input database, and searches can be conducted to find matches within this database. Once created, a database can then also be used as a ‘Search database’. This means an input database can be opened and each fluke can be used as the ‘target image’ and matched against a Search database. For example, if an operator created separate databases for their 2009 and 2010 field seasons, the 2009 season catalogue could be opened as an Input database, and the 2010 season as a Search database. Each fluke from
2009 could then be taken as the ‘target image’ and matched against the 2010 catalogue to search for resights.

**Creating a New Database**

⇒ [Database] > [Make New Database]

Give the new database a name (avoid using any spaces). For example, you may create a database to contain all of the flukes collected within one survey season at one location: a database named “PS_2009_HBnm” may contain all of the photos taken off Port Stephens during the 2009 humpback northern migration.

Each time an existing database is opened a password is required. There are 3 levels of protection that can be enforced when a database is opened:

1) Only the year and location is shown for photos stored in the match database
2) The date, position and other data is also shown
3) The user can edit and add new records to the database.

Enter 3 passwords for the various levels of protection (max. of 8 characters). After pressing ‘OK’ the program will create empty database files which are placed in a folder of the same name as the database. *Fluke Matcher* will create the following database files:

*.FDB (Flukes Database) contains the information about each fluke in the database:
   - co-ordinates of the control points
   - black/white percentages for each region
   - some data about the trailing edge and v-notch area
   - feature type, location and associated data
   - etc.

*.FPF (Flukes Photo File) contains information about each photo of each fluke:
   - date and time of photo
   - location
   - name of photographer and company
   - photo quality
   - etc.

*.FTF (Fluke Thumbnail File) holds a thumbnail image of each photo in the database. This file is used to speedup the search process and can be a very large file.
*.FVF (Fluke V-notch File) is the original name for the data file containing data about the v-notch area but now also includes data on Image Features.

*.FMF (Fluke Match File) is a data file which has a list of the confirmed matches to other flukes (contains links to any *.FDB file).

Opening an Input Database

⇒ [Database] > [Open Input Database]
This operation will open the primary database which is used to input new flukes or edit old data, or simply used to open old fluke images which are then matched to the same or other databases. Note that when Fluke Matcher is first started it will open the last input database used. A password is required to be able to open the database. The ‘Input’ database will initially also be made the ‘Search’ database.

Opening a Search Database

⇒ [Database] > [Open Search Database]
This operation will open the search database. This is the database that is used to search for any potential matches. A password must be entered to be able to use the database.

Managing Databases

It is up to you how you manage your database(s) and whether you would prefer to have several smaller, more manageable databases, or instead have one very large database that includes all of your data in it. Fluke Matcher has the ability to merge databases together, as well as to export individual records from one database to another, and therefore you can decide which option suits you best (see below for instructions).

How you manage your databases will be depend on the questions you wish to ask of your data and the matching exercises you need to conduct. For example, if you created a database to contain all of the flukes collected off Port Stephens during the 2009 humpback northern migration (“PS_2009_HBnm”), then you may wish to create separate databases for the 2010 and 2011 seasons (e.g. “PS_2010_HBnm”, “PS_2011_HBnm”). You could then merge all three databases into one larger database called “PS_HBnm” to match against a fluke catalogue from another location (but still retain a copy of the smaller databases if you wish).

In deciding how to manage your data, it should be noted that the greater the number of images of each whale in a given database, the more efficient Fluke Matcher will be at finding matches during the search process. Therefore a balance must be reached between the costs of having a large database that might take a few extra seconds for Fluke Matcher to search through, compared with the benefits of being able to search all of the
flukes in your dataset at once, and the likelihood that you will find matches faster if there are multiple images of each whale in the database (e.g. by including all of the images of a given whale over several seasons).

**Merging Databases together**

⇒ [Database] > [Append Search Database]
To add two databases together, open the INPUT Database and then open the database you want to add to the end as a Search Database. Then use the append option in the database drop down menu.

**Extracting records from one Database to another**

⇒ [Open INPUT Database] > [Open SEARCH Database] > [Database] > [Database Info] > Tick the records you want to export in the ‘SR’ column > [OK] > [Database] > [Export Selected Records] > [OK]

To extract records from an INPUT Database to another database, open the other database as the SEARCH Database (it can be a new one you have just created), then go to ‘Database Info’ in the ‘Database’ drop down menu, tick the records you want to export in the ‘SR’ column and click ‘OK’. Then go to ‘Export Selected Records’ in the ‘Database’ drop down menu, this will bring up the ‘Database Info’ with the ticked records again, then push ‘OK’.

**Entering a New Fluke Photograph**

Once a database has been created, Fluke Matcher creates a new folder for that database. It is best to copy all of the images that you want to enter into any database into a single folder that contains all of your images inside the ‘Fluke_Matcher’ folder. For example, create a single image folder within the ‘Fluke_Matcher’ folder called ‘All_images’, and when you enter flukes into a database, always choose them from this folder. Note that the images don’t have to be in the ‘All_images’ folder if you’d prefer to put them in another location, but it is important not to move them from their location once they have been entered into a database.

⇒ [Photo] > [Load New Image]
Select the new image and press ‘OK’. The new photo will be displayed.

**Stage 1  Measure Major Control**
Left mouse click on the 5 major control points in the following order

1) Left Tip (estimate position if fluke tip is bent or curled)
2) V-Notch
3) Right Tip (estimate position if fluke tip is bent or curled)
4) Right Base (estimate the position if leading edge is underwater)
5) Left Base (estimate the position if leading edge is underwater)

Then:

6) Click on White pigment (choose darker shadow area)
7) Click on Black pigment.
Locating Left and Right Fluke TIP Positions

The location for control points 1 and 3 at the tips of the flukes is dependent on the shape of the tip:

Pointed Tips – the top of tip (apex point). Note the control angle (yellow) will be less than 180°.
Rounded Tips – the point near the extreme end of the fluke. Note the control angle (yellow) will be greater than 180°.

If the fluke is bent or curled near the tips then estimate the correct position as if the fluke was not bent. It is important to get this correct as the position of the fluke tips will determine the horizontal scale of the image and the shape of the tip region.

Once the major control points are measured you are required to adjust all of the control points, including the 5 major control points if they need adjusting.
**Stage 2   Adjust All Control**

Left mouse click or drag all the control points to their correct position such that they outline the fluke:

1) All points should lie just outside the edges of the fluke and a better estimate for their position can be made if the fluke is bent. The two base major control points may have to be re-adjusted (they may have been shifted by the program).

2) The points shown with a green cross can only be moved up or down.

3) Points A (2 of) should be positioned at the base point on the inside of the fluke tips and will aid to specify the shape of the fluke tip (as above).

4) Points B (2) should be positioned so that they indicate the angle at the V-notch and the general shape in that area.

5) Point C must be positioned so that it lies at the centre of the stock area and also **at the water level if parts of the fluke are underwater**.

6) Points D (6) should be positioned so that most of the trailing edge lies inside the polygon.
Stage 3  Process Image

After all control points have been adjusted then the image must be processed.

Click on the ‘Process Image’ icon (green circle) or select Process Image under the Photo menu.

1) **Measure Left Trailing Edge.** Move the window so that the red cross is placed at the edge of the fluke by using the arrow keys or buttons (only move the window up and down). Adjust the Threshold and B/R ratio so that trailing edge black band becomes well defined in the left window. Use the red square and original image (right window) as a guide. The pink squiggly line at the bottom of the left window indicates the shape of the trailing edge; humps and hollows are a measure of the trailing edge shape above or below the average shape of the trailing edge. Any very high peaks may be caused by black being measured in the water above the trailing edge and can be eliminated by turning the frame on (‘Frame ON/OFF’ button). Large pits will be displayed at any gaps in the trailing edge black band. A general shape value is displayed at the bottom right of the dialog box (‘Shape ~’); zero means a straight line and values of 100 or above indicate the trailing edge has many large peaks and pits. Adjust the value of the ‘Quality/Contrast’ from 1 for very good to 5 for very poor. If it was difficult to remove water or shadow on the left window then use a value of 4 or 5. Press the Accept button.

2) **Measure Right Trailing Edge.** (as above)

3) **Measure V-Notch Area.** Move the window so that the red cross is placed at the bottom of the V-notch (use the right window as a guide). Adjust the Threshold and R/B ratio so that any black areas are well defined. A red outline will display the general shape of any black areas below the V-notch, it is not an exact measure of the shape of the black regions but is a measure of the amount of black pigment in radial direction from the V-notch (and thus may look slightly incorrect at times).
Fluke Matcher then breaks the fluke up into 18 regions, calculates the amount of black pigmentation in each region (shaded red & green), estimates the thickness of the black band along the trailing edge and calculates some angles and distances on the fluke. All the results are shown in the table.

4) **Correct the values for the Control Point Quality in the grid field.** In this case the left base point is underwater and the fluke is very bent near the LT control point. The quality of the control points is used during the matching phase, and should indicate how well the point is positioned. If a reasonable estimate can be made for the points position (maybe it’s just underwater) then leave the quality as ‘average’. Also take note of any regions that have not been shaded properly; region L6 is not entirely shaded.
5) **Correct the amount of black in the regions.**

Click on the *Select Region* icon in the toolbar. Then click the left mouse button within the region to be changed.

Use the menu adjustment controls (or the shortcut keys) to change the amount of black in the region until it appears correct. If the black region has gaps in the shading (as illustrated) then try adjusting the B/R ratio to correct this. NOTE: if all the regions need to be changed (if they are all too black or white) then edit one region as above and then click on the *Re-Set All Regions* button.

---

**Stage 4  Measure Additional Features**

Marks on the fluke can be measured as additional features. There are 4 types of additional features:

- **Spot Features** (max. of 12; 8 different types)
- **Area Features** (max. of 8; 4 different types)
- **Line Features** (max. of 8)
- **Image Features** (max. of 4)

Any marks that help identify the fluke should be measured as additional features. It is very important that these features are measured in a consistent way. Please see the section ‘Measuring Additional Features’ for detailed protocols about this process.

**Stage 5  Run a Search (optional)**

⇒ [Search] > [Auto Search]

If the new fluke is being added to an existing catalogue that may already have a record of the fluke, then it may be advantageous to first search the database for that fluke. If no match is found then save the new fluke data.
Stage 6  Save Fluke Data
⇒ [Database] > [Save Fluke Data]

A dialog showing the photo information will appear. Many of the fields may already be filled in (some will come from the image file; other data is estimated by Fluke Matcher). But it is important to have at least the ‘Photo Quality’ scores correct and have the time and date of the photo correct. All other data is optional, but may be very useful when searching within other databases. Press ‘OK’ to save the data.
Measuring Additional Features

Features measured on or near the trailing edge are much more significant in *Fluke Matcher* compared with features closer to the leading edge, because they tend to be visible even when the fluke is partly underwater. Thus Additional Features should be measured in the following way:

*First, take an overall look at the fluke image and note which features you would normally use when doing manual pair-wise matching. These features are also important for the matching techniques used in ‘Fluke Matcher’. If there are any particularly distinctive features these can be measured as both a normal feature (e.g. a hole), and as a ‘Focal feature’.*

Try to measure features in the following way:

1. **Spot Features.**

1) First measure any highly distinctive spot features (Focal Features) near the trailing edge, such as large black spots, large gaps in the trailing edge, holes or very large peaks in the trailing edge, etc, that can be used to quickly identify the fluke (if there are any; very few flukes may have such a feature). Then re-mark the feature as a Focal Feature; select ‘Focal Feature’ from the toolbar, mouse click near (but not on) the feature and move the yellow square over the mark with the arrow keys. Note: lines can also be marked as a Focal Feature if it is the only distinctive mark on the fluke.

2) Peaks along the trailing edge. If there are larger or prominent peaks along the trailing edge then measure up to 2 or 3 on each side of the fluke. If there are more than 3 then first measure the one closest to the notch and the one closest to the tip, and do the others later if not all 12 spot features have been used. Large peaks that have 2 small apex points can be measured as one large peak.

3) Marks along the inside of the trailing edge black band. If there are bleed marks (lines starting at the trailing edge) or other marks that touch the trailing edge then measure up to 3 on each side of the fluke.

4) Gaps or Indents in the trailing edge. Measure any gaps in the trailing edge.

5) Holes. Measure any holes on the fluke.

6) Spots, circles and crescent shapes. Measure any remaining spots etc. on the fluke, especially those nearer the trailing edge.
There is a limit of 12 spot features so only choose those features that will be the most useful at identifying the fluke. If there are a number of the same type of spot marks close to each other, first measure one (the largest or the closest to the trailing edge), then only measure the remaining ones after all other spot features have been measured. If there still remains other outstanding features such as peaks or marks near the trailing edge, then measure those as well.

If you are unsure about which type of feature to pick for an important feature, then mark it as 2 or more different features (for example; a major bleed mark may also be measured as a line).

**Flukes without many good additional features (e.g. less than 3) should be measured by marking the inside 2 or 3 peaks on each side of the fluke (i.e. from the V-notch working out, as shown by #’s 1,7,8,9,10 & 11 below):**
2. **Area Features.**
1) Measure any Damage Area features. If unsure as to whether an area is a Damage Area or not, then use Area of Interest.

2) Measure any Area of Interest features. These should include unusual shapes along the trailing edge, especially if there are very few spot features on the fluke.

3) Measure any areas of spots, especially if there are too many (5 or more) to be measured as individual spot features.

3. **Line Features.**
Measure any prominent line, straight or curved, as a line feature. It is not necessary to measure lines that may be inside an Area feature unless they are large enough to be an outstanding feature on their own.

4. **Image Features.**
Some flukes (but only very few) have marks that are unusually shaped that are suitable for measurement as an Image feature. *Fluke Matcher* will utilize the size and shape of the feature when it does a search. Image features need a lot more computing power than other features and can slow down the search quite considerably, so should be used sparingly.
Measuring Spot Features

There are 8 different spot features:

1. Peak on trailing edge
2. Bleed Mark on trailing edge. Any line or spot touching trailing edge band.
3. Gap or indent in trailing edge
4. Spot
5. Circle
6. Crescent shape
7. Hole in fluke

Eight different types of spot features, shown before and after measurement.

Note: a Focal Feature is measured twice: Once normally as a spot, hole, gap, peak or line and then as a Focal Feature. When adding a Focal Feature over the top of an existing feature, click the mouse near the feature and then move it to the correct position with the arrow keys.

To measure a spot feature; click on the appropriate feature icon on the toolbar and then click on the location for that feature. Use the arrow keys to move the feature and the numeric ‘+’ and ‘-’ keys to change the size.

A spot feature can be edited by clicking the mouse on the feature and then adjusting the position or size. Use the Delete icon (or delete key) to delete the last spot feature measured. Any mark can also be measured as two or more additional features. When marking the second spot feature, mouse click near the first and then move it with the arrow keys, otherwise clicking on an existing feature will re-select that feature.
Measuring Area Features

There are 3 types of area features:

1. Damage Area. This may be an area of rake marks (i.e. at least three parallel lines or marks consistent with the teeth marks of predators of humpback whales, such as killer whales), or a missing section of the trailing edge.
2. Area of Interest. Area of interesting marks or trailing edge.
3. Area of Spots. Many spots or circles concentrated in one area.
4. Area of Line Marks.

Examples of Damage Area feature. 
Note: Area 2 should be marked as GAP as well.

Example of Area of Interest feature. 
Note: Area 3 should be marked as GAP as well.

To measure an area feature, click on the appropriate feature icon on the toolbar and then click on the position of the top left corner for the area feature. Then click on the bottom right corner. Use the arrow keys to move the feature and the numeric ‘+’ and ‘-’ keys to change the size.

Measuring Line Features

To measure a line feature; click on the appropriate feature icon on the toolbar and then click on the position of the most top left end of the line. Then click on the other end. Make the size of the area feature just cover the area. Use the arrow keys to move the feature and the numeric ‘+’ and ‘-’ keys to change the length.
**Measuring Image Features**

First select the Image Feature icon on the toolbar and then click the mouse on the image feature. Measuring an Image feature is done in the exactly same way as the V-notch area.

Try to isolate the unusually-shaped feature within the window (i.e. move the window around so that other (irrelevant) marks are moved outside the window). Notice with this example that the image feature is not in the centre to ensure that other marks (out of screen on the left of the image feature) are removed and only the feature itself remains. **Round spot shapes do not make good image features as they all look alike.**
More Examples:

Gaps or Indents in trailing edge.

Gaps may appear along the trailing edge.

Large Indents in the trailing edge should be measured as a Gap feature (#7). They can also be measured as an Area of Interest (#1).
**Area of Damage**

Very short rake marks.

**Area of Interest**

Hazy (unclear) marks near Trailing Edge.
Area of Spots

The yellow Areas 2 and 3 in the above example are Areas of Spots. It is best to measure separate areas on each side of the fluke. Pick a few of the more prominent spots as individual spot features. (Red area is Damage area). Longer rake marks can also be picked up as line feature.

Spots

Major Spot on clean fluke (white fluke with very few features) also measured as Focal Feature. Any spots not round in shape should be measured as Crescent Feature.
Bleed Marks

Any line type feature that joins onto trailing edge. Note #2 has been offset to show detail. Only measure small bleed marks when no other prominent marks can be found.

Major bleed marks should also be measured as line feature (line#1 & spot#2).

Bleed marks sometimes are found around V-notch area.
Search

⇒ [Search] > [Auto Search]
⇒ [Search] > [Feature Search]

etc.

There are 5 choices on how a search can be done:
0. Auto Search
1. Standard Search
2. Trailing Edge Search
3. Feature Search
4. General Search.

The Feature Search usually has the best results and should be used first.
The ‘Feature’ search is based on the standard search except that more weight is given to features and the trailing edge. It will also use image matching techniques to match Image features and the V-notch area.

If ‘Auto’ search is used Fluke Matcher will utilize the photo and control point properties as well as the number of features measured on the fluke to determine which of the other search techniques is best suited for that particular fluke (usually Feature Search). The ‘Standard’ search’ uses standard techniques and weights to perform the search. More weight is given to focal spots, lines and areas. The ‘Trailing Edge’ search is similar to the standard search except more weight is given to any features and measurements on the trailing edge.

To conduct a search click on the [Search] menu item and then select the search technique.
The results of the search are shown in a large dialog box. The original image is the large picture on the left and the ‘selected’ matched fluke is on the right, which is initially the best match determined by Fluke Matcher. The top row will initially contain the first 5 ranked matches as computed by Fluke Matcher (rank # shown on button below image as well as the Match Index and the image number). The user can scan through the rank images to locate any true matches using the buttons available:

[rank #] > will select that image and place it in the large image on the right, show all results in the table and on the bottom right of the dialog box.

[Next 5>] > will show the next 5 ranked images along the top.

[< Prev. 5] > will show the previous 5 ranked images along the top.

[First] > will select the #1 ranked image (quick way to go back to start of list).

[Next Image] > will select the next image (easy way of going through the list one image at a time).

[Prev. Image] > will select the previous image.

[Accept] > accept the selected image and write results to the match database.

The search number used is shown on the right of the dialog box. If no match is found within about the top 10% of the list then a different search method can be used; quit out of the search results and try another search method (do not use auto search again as it will use the same search method again).
**Fluke Matcher keyboard shortcuts**

To clear the screen of red/green highlights before measuring additional features, push the ‘Backspace’ key.

Threshold up \(\text{‘w’}\)
Threshold down \(\text{‘q’}\)
Blue-red ratio up \(\text{‘p’}\)
Blue-red ratio down \(\text{‘o’}\)

Use arrow keys to move a feature in the respective directions.

Increase feature size \(+\) (hold ‘fn’ and ‘?’ if Mac keyboard)
Decrease feature size \(-\) (hold ‘fn’ and ‘:’ if Mac keyboard)

Delete last feature \(\text{‘Delete’ (hold ‘fn’ if Mac keyboard)}\)

If you want to restart the measurement of a fluke and the image disappears (leaving a blank white screen), push ‘Delete’ and the image should return.
**Fluke Matcher Protocols Summary**

Fundamental measurements:

1. Measure the **5 major control points** (in order – Left tip, base of notch, right tip, right base, left base)
2. **Set the white threshold level** by clicking on a darker area of white on the fluke (e.g. in shadow).
3. **Set the black threshold level** by clicking on a solid area of black pigmentation.
4. **Adjust the minor control points** to outline the fluke (but it’s better to click further outside the fluke and include some ocean than to chop parts of fluke off)
5. Click the ‘Process image’ button.
6. **Adjust the left trailing edge thickness**. First move the window so the crosshairs just touch the top of the trailing edge. Adjust the black threshold and blue/red ratios up or down until the image on the left best represents the actual image on the right. If needed, push the ‘Frame On/Off’ button to exclude the water behind the fluke from the measurement.
7. **Adjust the right trailing edge thickness**. As above.
8. **Adjust the notch area**. First move the window so the crosshairs are at the base of the notch. Adjust the black threshold and blue/red ratios up or down until the image on the left best represents the actual image on the right.
9. **Adjust the quality of the major control points** in the fluke info window that appears. If one of the fluke tips is off the edge of the image change the quality to ‘Underwater’. If the tip has been torn off (e.g. by predators or vessel strike) change the quality to ‘Missing’.
10. **Adjust the black pigmentation in the regions** (Select a region, adjust it using the threshold and blue/red ratios, then ‘Reset all regions’ if needed. If only one or two regions need adjusting, select them separately and adjust without clicking the ‘Reset all regions’ button).
11. Once you are happy that the green and red shading displayed by *Fluke Matcher* best represents the actual areas of black pigmentation on the fluke, **push the ‘Backspace’ key** (or ‘Delete’ on a Mac keyboard) to clear the image ready for measuring any Additional Features of the fluke (see below).
**Measurement of Additional Features summary**

1. Before measuring any additional features, decide if any of them should be highlighted as a **Focal Feature**. The Focal Feature function should be used sparingly and only if there is a very prominent and obvious feature on the fluke. If there is a Focal Feature, measure it normally first (e.g. as a spot, a circle, a large gap in the trailing edge, etc.) and then click on the ‘Focal Feature’ button. Click near the feature (but not directly on it) and then move the box into position over the feature. N.B. If you click directly on the feature *Fluke Matcher* will instead remeasure the old spot feature.

2. Measure up to **4 prominent Peaks** on the fluke. ONLY MEASURE PEAKS IF THEY STAND OUT PROMINENTLY. This may consist of two peaks on each side, or three on one side and one on the other. Never measure more than three peaks on either side of the fluke. If you measure too many peaks, or if you choose peaks that are not particularly prominent, it is likely to make the results worse.

3. Measure any **Gaps in the trailing edge**. If unsure about a possible “gap”, don’t measure it unless there are not many other features on the fluke.

4. Measure any prominent **Bleed marks**. If unsure, don’t measure it unless there are not many other features on the fluke. Even then be sparing.

5. Measure any other **Spot Features, including circles, spots, crescents and holes**. Choose the most prominent spots, circles, etc., but tend towards those nearer the trailing edge rather than the leading edge. But it’s still ok to measure spot features near the leading edge if they are very prominent.

6. You can measure up to a total of 12 of all of the above measurements combined (Focal Features, peaks, gaps, bleeds, spots, circles, crescents and holes).

7. Measure any **Lines** on the fluke. You can measure up to 8 lines. If there are two parallel lines close together then measure one thick line to represent both. If there are two lines running consecutively with a small gap between then just measure them as one long line. It’s better to choose fewer lines than more.

8. If any bleed marks are very long, measure them as lines as well as bleeds.

9. If there are areas of rake marks, measure the most prominent line amongst the rakes and also measure it as a Damage Area (see below).

10. Measure any **Damage Areas**. If there’s a definite gap between two damage areas, measure them as separate areas rather than one large one.

11. Measure any **Interest Areas**. This may consist of any group of distinctive marks that are close together. It’s ok to measure Interest Areas in the central region of the fluke near the peduncle if there are marks in that area. If there are not many additional features on the fluke you may also choose the notch area as an Interest Area.

12. Measure any **Areas of Spots**. Mark the most prominent spot or two in the group and then measure the whole area as an Area of Spots.

13. Measure any **Image Features**. These should be used sparingly and only if there is an isolated, unusually shaped, distinctive mark on the fluke.