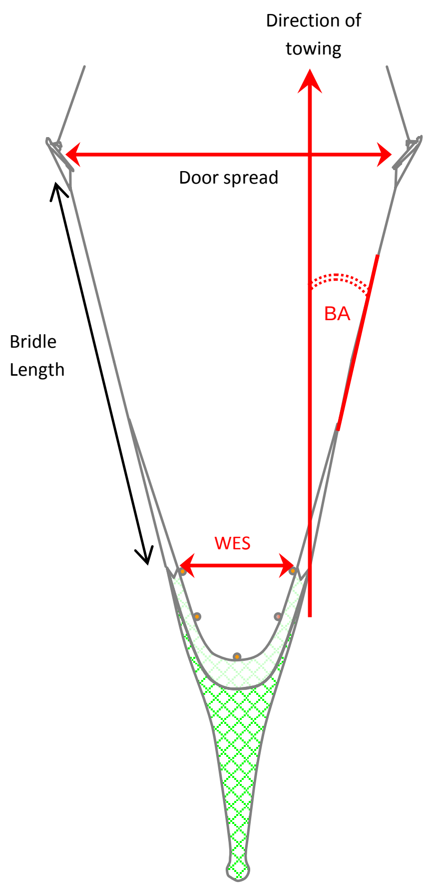
Bridle angle and wing end spread calculations

The bridle angle (BA) or sweep angle (SA) is the angle formed between the direction of towing and the sweeps and bridles. The wing end spread (WES) is a measurement of the opening of a trawl at its wing ends. Knowledge of these two parameters is paramount in optimising the spread of the trawl gear to ensure it maintains an efficient opening to suit the behaviour of the target species. This fact sheet will help make these calculations.



The bridle angle has a great effect on a trawls catching potential. A slight alteration in bridle angle can have a big influence on the bridles herding ability. A change of towing speed can also alter the herding characteristics of the bridles even if the angle remains the same. In some regions alternative terms are used when referring to bridles, such as sweeps, cables, ground ropes etc. For these calculations we shall define the bridle as the length of rope, wire, combination wire or chain that connects the trawl door to the trawl. The bridle may be made up of one or more of these materials.

The bridle length is the total length between the back of the trawl door and the net on one side of the gear, including all backstrops, shackles and lengths of chain.

As these calculations are based on trigonometry, however the distance between the trawl doors is also required. This can be calculated using the warp divergence method or by using electronic gear sensors. (See Fact Sheet on Door Spread).

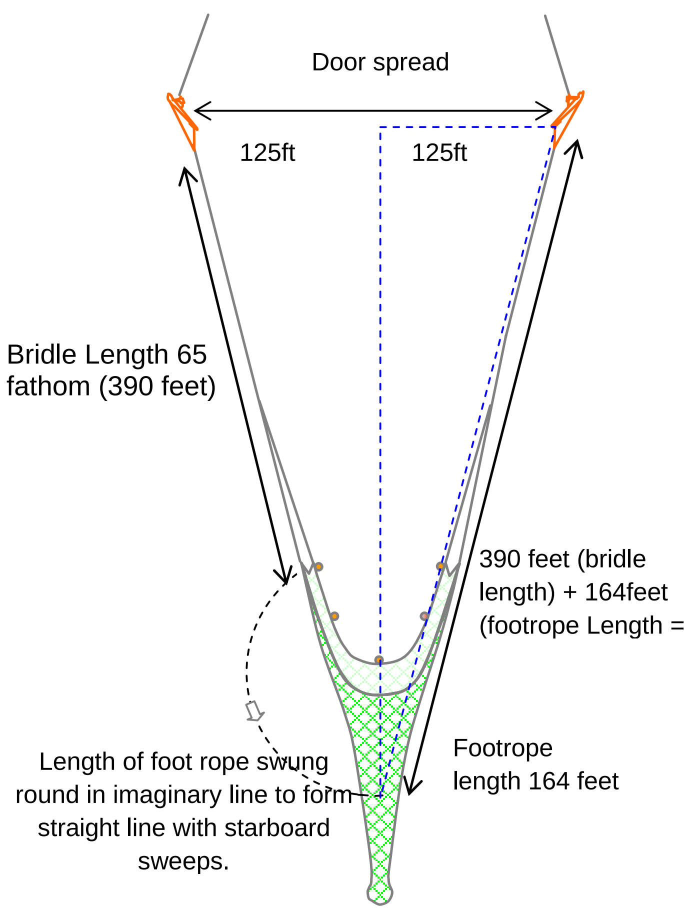
All the calculation methods that follow involve a certain amount of presumption that the bridles and net consist of a series of straight lines, as in the diagrams. It must be understood that in reality this will not be entirely true. However in comparison to measurements during sea trials using electronic distance sensors, these calculations do give respectable results.

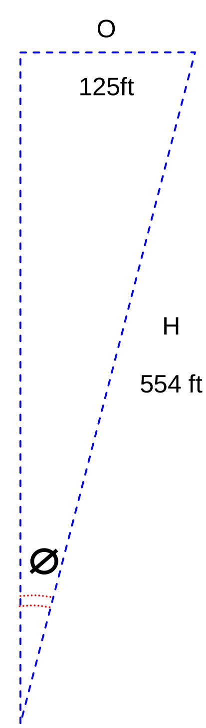
The calculations should be used as a comparison from one situation to another, rather than as an absolute measurement of the angle. When making a comparison, the same calculation method must be used. If the figures are being compared with those of another vessel, the other skipper must be using the same calculation method to ensure an accurate comparison. In a twin-rig set up the overall door spread (the whole distance from one trawl door to the other) should be divided by two. Each net and its respective bridles can then be treated as if it were a single trawl for these calculations.

Bridle Angle Calculation

This method uses the bridle length plus footrope length to form the hypotenuse of a triangle, and half the door spread to form the base.

Starting with the door spread (250 feet), divided by 2, gives 125. Add the bridle length (390 feet) and the foot rope length (164 feet) gives a total of 554 feet. This results in a right angled triangle with the dimensions below.





SIN Ø	BRIDLE ANGLE
0.13 - 0.16	8 degrees
0.15 - 0.16	9 degrees
0.16 - 0.18	10 degrees
0.18 - 0.20	11 degrees
0.20 - 0.22	12 degrees
0.22 - 0.23	13 degrees
0.23 - 0.25	14 degrees
0.25 - 0.27	15 degrees
0.27 - 0.28	16 degrees
0.28 - 0.30	17 degrees
0.30 - 0.32	18 degrees

$$\text{Sin Ø} = \frac{O}{H}$$

$$\text{Sin Ø} = \frac{125}{554}$$

$$\text{Sin Ø} = 0.225$$

By using the table above, find 0.225 in the SIN Ø column and read off the angle of 13 degrees from the BRIDLE ANGLE column. The Bridle Angle (sweep angle) is 13 degrees.

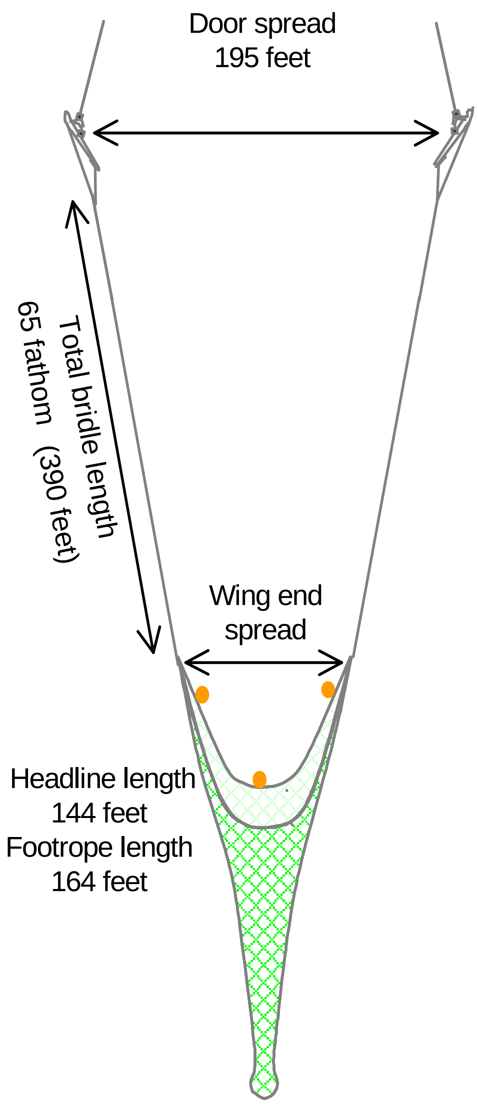
Alternatively use the Sin $^{-1}$ button on a scientific calculator -- Sin $^{-1}$ of 0.225 = 13.00 degrees.

There are various methods of estimating the bridle angle of trawl gear, the main advantage of this method is that it allows for a change in the shape of the net as the door spread or the bridle length changes. The same figures can be used to get an estimation of the wing end spread (WES) and gives an indication of changes to it as alterations are made to other gear parameters.

Wing end spread calculation

This calculation gives an estimation of a trawls' wing end spread. In most demersal trawl situations the wing end spread should be between 30% and 50% of the headline length. As in many trawl gear calculations the door spread is required. This can be calculated using the warp divergence method or by using electronic gear sensors.

$$\text{Wing End Spread (WES)} = \frac{\text{Ground gear length (GG) x Door Spread (DS)}}{\text{Bridle Length (BL) + Ground gear length. (GG))}}$$



$$\text{WES} = \frac{\text{GG} \times \text{DS}}{\text{BL} + \text{GG}}$$

$$\text{WES} = \frac{164 \times 195}{390 + 164}$$

$$\text{WES} = \frac{31980}{554}$$

$$\text{WES} = 57.7 \text{ feet}$$

This gives a wing end spread for this gear of 40% of the headline length.

If this calculation is to be used in a twin rig set up the overall door spread must be halved. Each net and its respective bridles can be treated as a single trawl for this calculation. In comparison with wing end spread measurements from electronic sensors during sea trials this calculation gives respectable results. However, in some situations (ie. very long net and short bridles) the results may be distorted and unreliable.

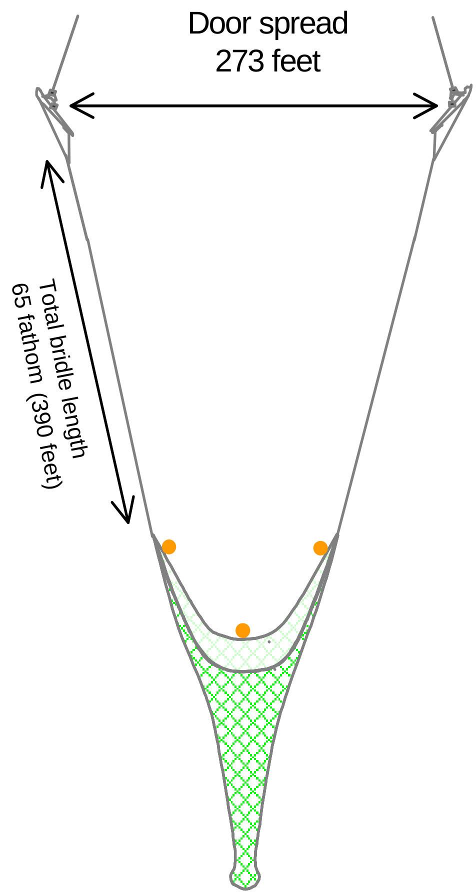
Both these calculations are available for download on the Seafish website at:
http://www.seafish.org/upload/b2b/file/r__d/DSandWEScalculationsAUTOprot_MikeM.xls

Door spread as a percentage of the bridle length

In some fisheries the skippers prefer to express their ‘target’ door spread as a percentage of their bridle length. Although this method is popular in several successful fisheries, it should be understood that as alterations are made to the rig (changes to bridle length or size of net), the door spread to bridle length ratio (percentage) may remain constant but there can be a substantial difference in the bridle angle and net wing end spread.

This method will give good results when comparing sets of gear with similar bridle lengths and nets of similar size. If there is any difference in the net or bridle lengths the results should be treated with caution. The examples below emphasise this fact.

In the initial scenario the single trawl rig (left) has a foot rope length of 164 feet, headline of 144 feet and a total bridle length of 65 fathom (390 feet).



The skipper’s target door spread is 60% of his total bridle length. 60% of 390 feet is 234 feet.

With a footrope length of 164 feet and a headline length of 144 feet, the calculation gives a sweep angle of 12.2 degrees and a calculated wing end spread of 69 feet or 48% of the headline length.

Summary Door spread as 60% of bridle length

Bridle length	80 fathom (390 ft)
Headline	164 feet
Footrope	144 feet
Doorspread	234 feet (60% of 390ft)
Bridle angle	12.2 degrees
WES	69 feet (48%)

Further examples follow.

1. If the skipper now adds 15 fathom to the bridles to give an overall length of 80 fathoms.

Summary	Door spread as 60% of bridle length	
	Bridle length	80 fathom (480 feet)
	Headline	164 feet
	Footrope	144 feet
	Door spread	288 feet (60% of 488)
	Bridle angle	12.9 degrees
	WES	73 feet (51%)

2. If the skipper shortens his overall bridle length by 15 fathom resulting in a bridle length of 40 fathoms.

Summary	Door spread as 60% of bridle length	
	Bridle length	40 fathom (240 feet)
	Headline	164 feet
	Footrope	144 feet
	Door spread	144 feet (60% of 240)
	Bridle angle	10.3 degrees
	WES	58 feet (41%)

This method will give good results but be aware that with different sweep and bridle rigs there can be a considerable difference in the herding ability of the bridle rig.

For more information contact Seafish gear technologists using the contact details below.

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