Planning and Cutting Nets

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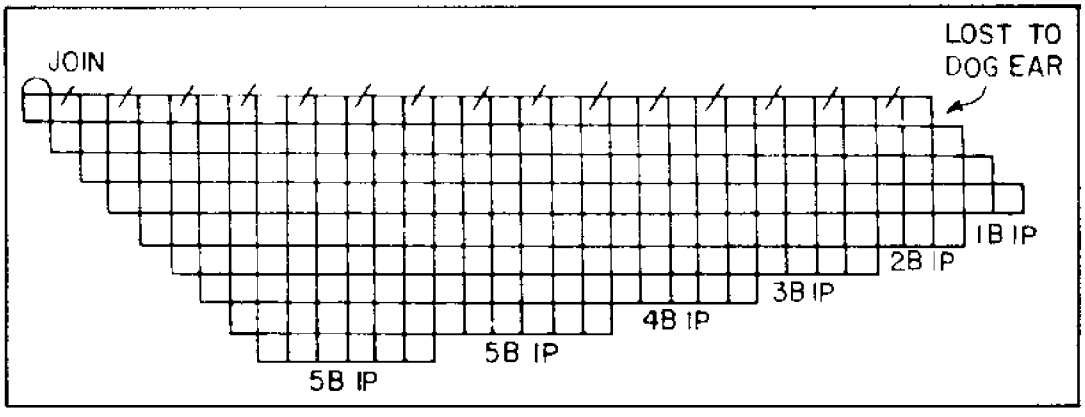
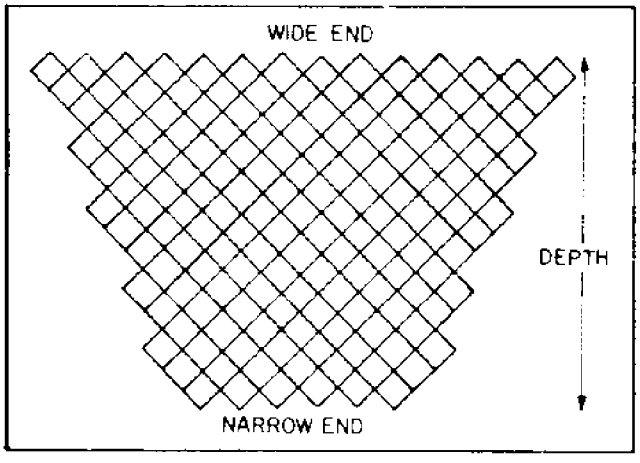
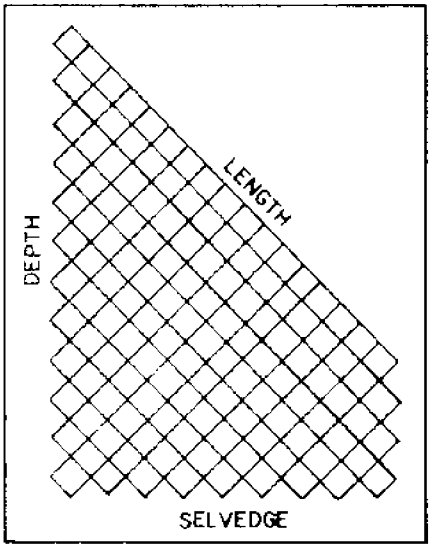
NOAA/Sea Grant







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NET-CUTTING INSTRUCTIONS

All midwater and bottom nets used in the world's fisheries are composed of sections called bellies, squares, wings, or jibs. These sections usually vary in mesh size and dimensions.

It seems that most net builders—often after trial and error—have developed their own methods of tapering these sections, which are easy to copy by counting them out. Many books have been published on planning and constructing nets and trawls, but nowhere can you find the netmaker explaining how he arrived at the figures for his tapers. Thus, in teaching the plan or scale to someone else, the explanation can be quite a problem.

The Department of Fisheries and Marine Technology at the University of Rhode Island made a start at improving this situation when Professor Geoffrey A. Motte developed a formula that can be used to determine any taper that might ever be needed in a net or trawl. James Kluver, a former student and now a commercial fisherman, modified the formula for lower wing tapers and explained how to apply it when the results are in fractions.

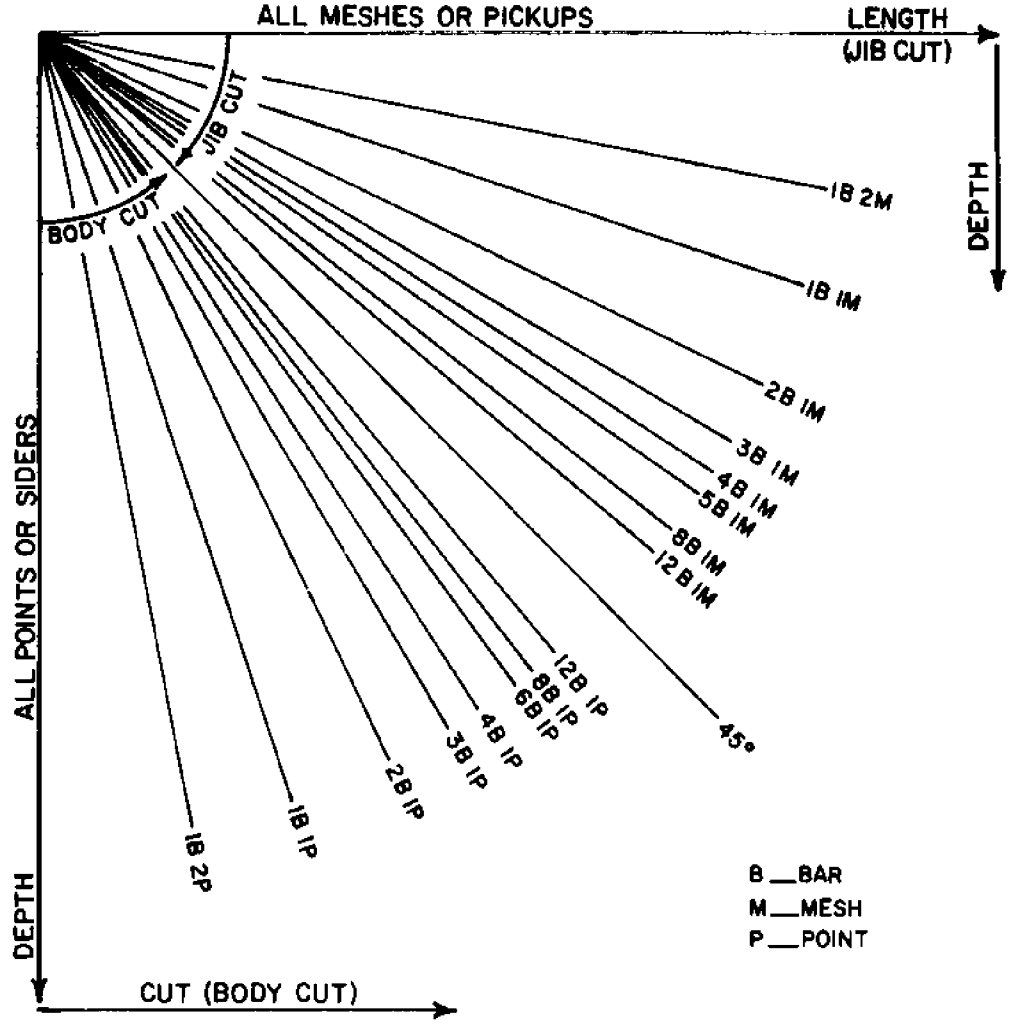


FIGURE 1. Angles resulting from cutting net tapers, assuming meshes are square.

Many net manufacturers will predetermine their tapers before making a net, but nowhere will you find a taper formula for doing this. We have discovered that by changing around our formula we can find out anything we need to know about tapering.

The formula itself is easy to work, but, like the carpenter's steel square, if it is not used properly, many wrong angles will be cut. My advice to the beginner is to use an old piece of webbing and cut a few tapers to make sure that he understands the formula completely before attempting to cut up a lot of expensive twine. The formula can be scaled down to any size, making it easy to test. For example, to demonstrate it for a square with the dimensions of 180 x 140 x 32, scale down these figures by any number that will divide equally into the three, such as the number 4, giving 45 x 35 x 8. The taper always will be the same, and, for this reason, a small piece of twine can be used to demonstrate the formula.

The basic formula, known as the *body cutting formula,* is used when a taper goes anywhere from a sider to a straight bar, or from a right angle to a 45-degree angle. A variation, the *jib formula,* must be used when the angle to be cut is greater than 45 degrees.

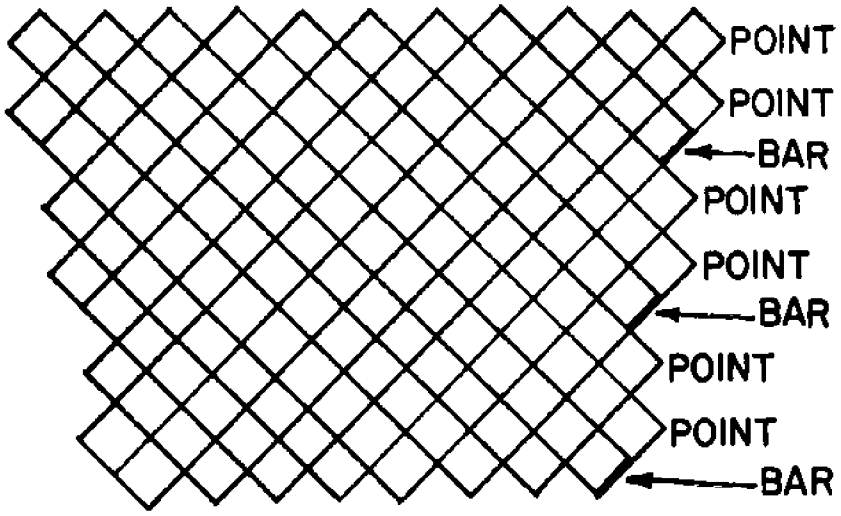
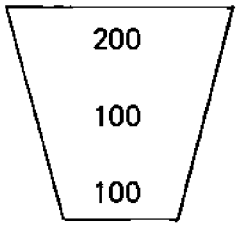


FIGURE 2. Body cut showing 2 points to 1 bar.

The experienced net man knows that if he needs a belly for any given net, and cuts it at a 2 bar 1 point taper, at a depth of 100 meshes, he will lose X number of meshes on each side. He knows that for every 2 bar 1 point cut he will lose a mesh, and will end up with the right amount of meshes on each end, but the amateur netmaker must be sure of what he is doing or a lot of twine will be wasted. In the example below, he must know two things: 1) the kind of taper he has chosen, and 2) the amount of meshes on the wide end. To find that out, he must first find the cut.

Example:

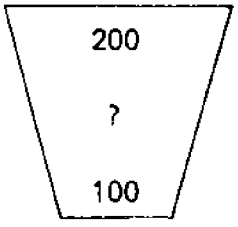


The cut will always be the taper multiplied by the depth and divided by the taper plus 2. Since he now knows that he will lose 50 meshes on one side, all he has to do to find the narrow end is to multiply the cut by 2 and subtract it from the wide end, which he already knows. If he knew the narrow end and not the wide end, he would add 2x the cut to the narrow end.

Example: $\frac{T \times D}{T + 2}$ $\quad 100 \times 2 = 100 \div X\ T + 2 = \frac{100}{4} = 50 =$ cut

The above formula will work for any taper regardless of fractions involved.

The following is the same example, with the depth unknown:



The cut is found by subtracting the narrow end from the wide end.

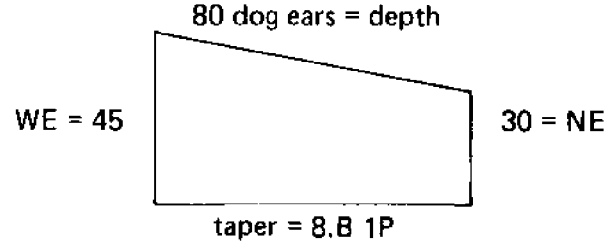
Example: $200 - 100 = 100 \div 2 = 50 =$ cut

Formula: $\frac{2C}{T} + C$

1. Multiply the cut by 2: $50 \times 2 = 100$
2. Divide by taper: $\frac{100}{2} + 50$
3. Add the cut: $50 + 50 = 100 =$ depth

To find the narrow end of a wing, you must first know the wide end, the depth, and the desired taper. All the dimensions are written in the example so that the formula can be more easily understood.

Example:



Formula: (NE = WE + C - D) + 1

To find the cut:

1. Multiply the depth by the taper: 80 x 8 = 640.
2. Divide the result by the taper: $+2\ \frac{640}{10} = 64$ = cut.
3. Follow formula: (45 + 64 - 80) + 1 = 30.

To find the wide end of the above example:

1. Find the cut in the same manner as in the above.
2. Follow formula (WE + D - 1) - C: (30 + 80 - 1) - C = 45.

BODY CUTTING FORMULA

Formula: 2c/d-c = taper

There are six points to keep in mind when using this formula:

1. c = cut (in meshes lost).
2. d = depth (cut in meshes).
3. Cut must be divided by 2 if both sides are to be tapered to form bellies, squares, or jibs.
4. If the depth is equal to the cut, the body taper is used and a straight bar will be the result.
5. If the cut is greater than the depth, the jib formula *must* be used.
6. If the difference between the cut and the depth is greater than twice the cut, the taper will be the body cut, but the taper will have more points than bars as shown in Figure 2.

This may all seem very complicated, but after a little practice, the formula and its variations will seem very simple.

Working Example*

Belly

Formula: 2c/d-c = taper

1. To find cut, first subtract narrow end from wide end: 140 - 50 = 90.
2. Divide by 2 if both sides are to be tapered. In this case, the cut = 90/2 = 45.
3. Subtract cut from depth: 80 - 45 = 35.

*Both squares and bellies are figured by exactly the same method.

4. Divide the difference (35) into twice the cut: $\frac{90}{35} = 2\frac{20}{35}$ or $2\frac{4}{7}$.

5. Since fractions cannot be cut, you must break the fraction down to find a workable taper. This is done by finding the lowest common denominator, which in this case gives $\frac{18}{7}$. Now you can cut 18 bars to 7 points, but to even the taper more, break down the $\frac{18}{7}$ into $\frac{3}{1}\frac{2}{1}\frac{3}{1}\frac{2}{1}\frac{3}{1}\frac{2}{1}\frac{3}{1} = \frac{18}{7}$.

To make this point, alternate 3 bars to 1 point with 2 bars to 1 point.

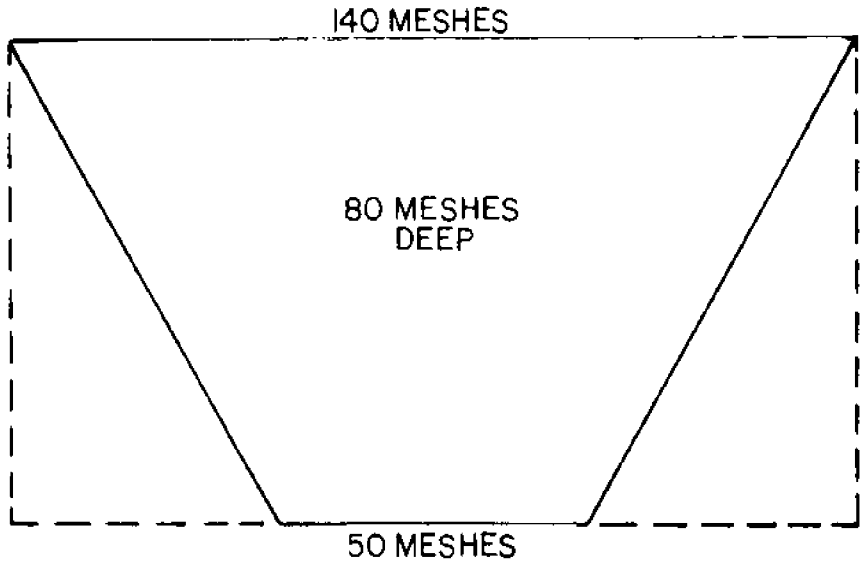


FIGURE 3. Working example of a belly.

Wings

Tapering for the lower wing is a little different than that for the rest of the net since there are two different tapers. The dog ears must be on a straight bar, leaving only one side to be tapered.

Formula: 2c/d-c = taper
Dimensions: 45 x 30 x 80 dog ears, or 160 bars

1. The cut of this wing equals the number of dog ears (or meshes deep) plus the NE - 1 minus the WE: 80 + 30 - 1 - 45 = 64 which is the cut.
2. Subtract the cut from the depth: 80 - 64 = 16.
3. Divide the difference between the cut and depth into twice the cut: $\frac{128}{16} = \frac{64}{8}$ or $\frac{8}{1}\ \frac{\text{bars}}{\text{point.}}$
4. The taper for this wing equals 8 bars 1 point.
5. Add 1½ meshes to wide end and narrow end for each pair of lower wings: 45 x 30 + 1½ = 76½ meshes required.

Since all wings should be made in pairs to save twine and must be cut from a square piece of twine, to figure the amount of twine needed to make one pair of wings you add the narrow end to the wide end and add 1½ meshes. The reason for the extra 1½ meshes, as seen in Figure 4, is that one mesh is lost when the square piece of twine is cut on a straight bar and the ½ mesh marked three-legger is used to start and finish or when sidering the two pieces back together. The needle will be joined at point A, two bars length will be joined to point B and sidered together, and you finish at point C. You now have a piece of twine that looks like Figure 5. Before the taper is cut, be sure you understand Figure 11 on page 9. To determine the wide end or narrow end of any wing, pick up any mesh and follow it to the straight bar or dog ear edge. If you run out of twine, you are going toward the narrow end. See arrows in Figure 6.

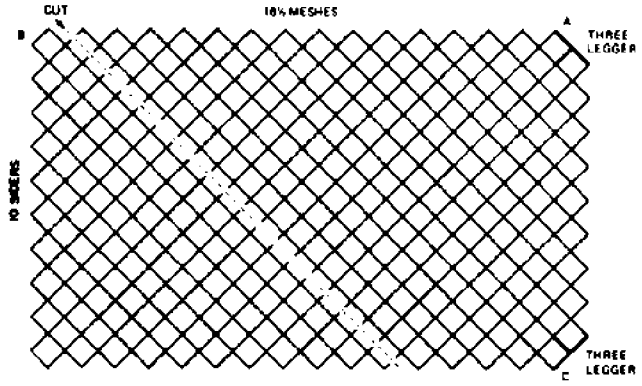


FIGURE 4.

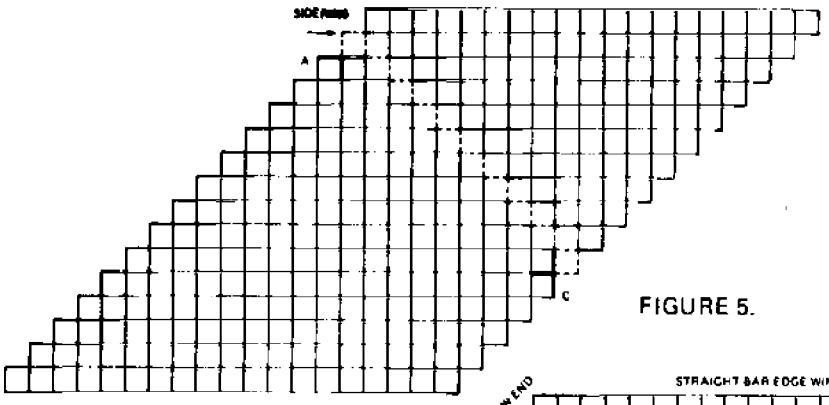


FIGURE 5.

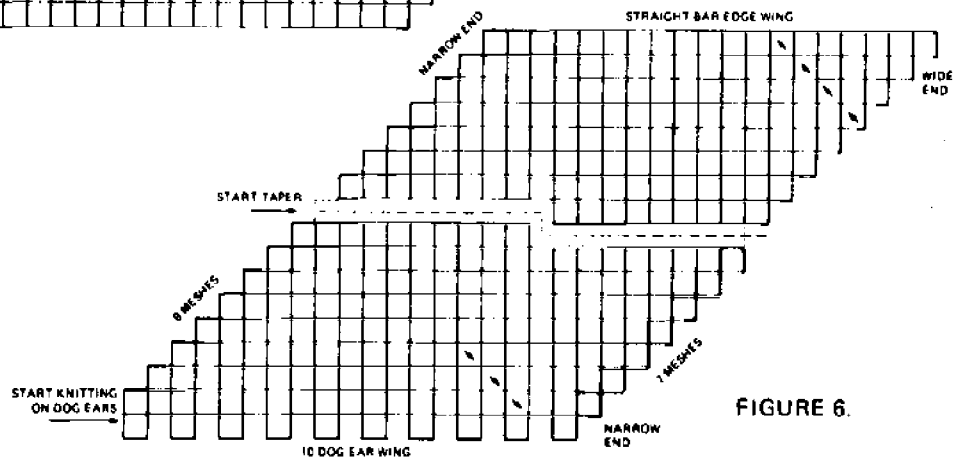


FIGURE 6.

"V" Cuts in Wing End

Some fishermen who wished to cut the wings back on a "V" found that the straight bar did not take the V back far enough. Because no formula was available it was done by guess, but I have found the body cutting formula will indeed give the right cut for the desired V. Consider a top wing with dimensions of 60 x 10 x 50 dog ears (Figure 7). In this case, the selvedge is all siders, and we want to leave five meshes on the door end and cut the V back to the depth of 15 dog ears. At that point in the wing we have 25 meshes—the difference between the wide end and the depth of 60 meshes that we want to make the taper. We lost 35 meshes when we cut the dog ears, so the piece of twine we want to taper is 25 x 5 x 15 dog ears, which, using the formula, works out to 1 bar to 1 point.

Formula: 2c/d-c = taper

Decide how far back into the wing you want the cut. Count the wing across from A to B and count the dog ears from B to C. Decide how many meshes are to be left on the door end from C to D in order to get the proper taper.

1. To find cut, first subtract number of dog ears from number of meshes across from A to B: 25 - 15 = 10.
2. Subtract number of meshes on door end from difference: 10 - 5 = 5, the cut.
3. Subtract the cut from the depth: 15 - 5 = 10.
4. Divide the difference into twice the cut: 10/10 = 1. Therefore, the taper is 1 bar to 1 point.

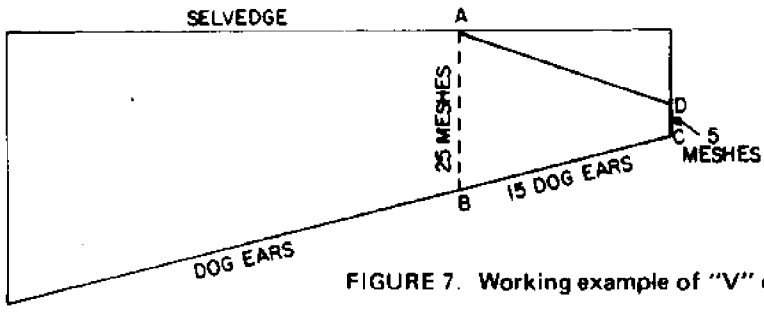


FIGURE 7. Working example of "V" cuts in wing end.

THE JIB CUTTING FORMULA

The jib in a net is usually found in the quarters between the square and top wings, and between the lower wings and belly. Although they are seldom found in New England nets, they are very common in the southern shrimp fleet. In all the nets I have examined as well as in the government pamphlets on shrimp trawls, I have found the taper always to be 2 bars to 1 mesh. Because the body cutting formula will not work for any angle greater than 45 degrees, we devised a workable variation for any jib cut.

The illustrated example shows how to use the jib formula. Note that the taper reads bars and meshes instead of bars and points. A point means the side of the mesh, or sider; and mesh means the end of a mesh, or pickup. By comparing Figure 8 with Figure 13, these terms can be easily understood.

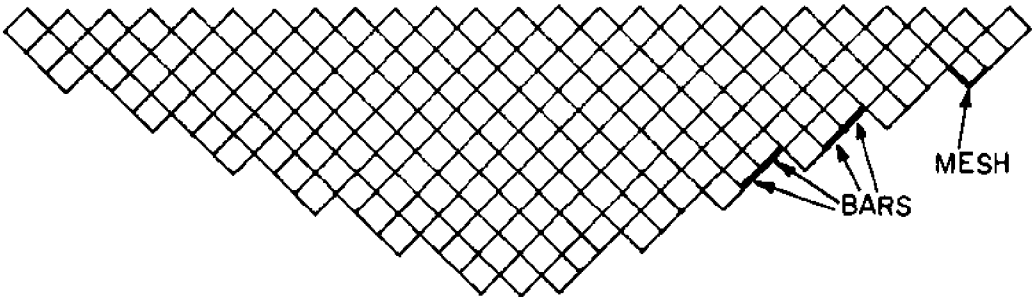


FIGURE 8. Jib with dimensions of 25 x 3 x 7 deep and a taper of 2 bars to 1 mesh. Note that the taper in the jib cut is in meshes instead of points. Take caution in cutting jibs due to the difference between a point and a mesh.

Formula: $\frac{2\ D\ -\ 2}{C\ -\ D\ +\ 2}$

1. To find cut, first subtract narrow end from wide end: 25 - 3 = 22.
2. If both sides of the jib are to be tapered, divide the cut by 2; this will give the cut on each side of the jib section: 22/2 = 11.
3. Multiply the depth by 2 and then subtract 2: 2 x 7 = 14 - 2 = 12.
4. Divide the difference between cut and depth plus 2 into twice the depth minus 2. Twice the depth - 2 = 12 (2 x 7 = 14 - 2 = 12). Cut - depth + 2 = 6 (11 - 7 = 4 + 2 = 6). $\frac{12}{6} = \frac{2}{1}$ or $\frac{2\ \text{bars}}{1\ \text{mesh.}}$
5. Taper for cutting jib section = 2 bars 1 mesh.

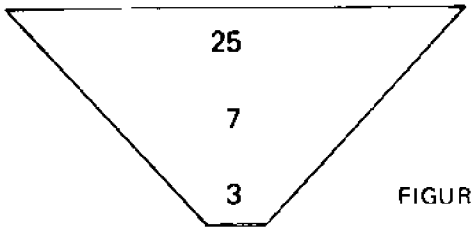


FIGURE 9. Working example of a jib.

EXTENSION PIECE FORMULA – WATCH OUT!

We have seen how the formula works in every section of the net but one, the extension piece, where most skippers prefer a very slight taper.

Suppose the required dimensions of the extension are 50 x 30 x 50 deep. This is where the formula will play a trick on you if you don't use it correctly–but like the carpenter with the steel square, you can do anything with it, if you do use it properly. In this case, twist the formula a little.

Follow the usual steps until you find that when the cut is subtracted from the depth it is found to be less than double the cut and, thus, cannot be divided. However, overcome this problem by dividing *twice the cut* into the difference between the cut and the depth.

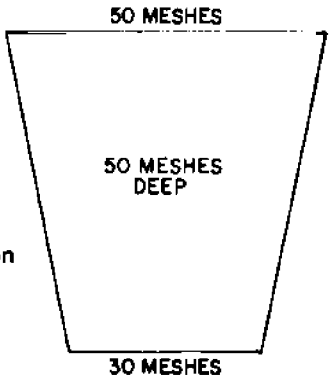


FIGURE 10. Working example of extension cut.

Extension Cut Example

Formula: 2c/d-c = taper

1. To find cut, 50 - 30 = 20/2 = 10, the cut.
2. d-c = 50-10 = 40.
3. When the difference between the cut and the depth is greater than twice the cut as it is here, double the cut and divide this figure into the difference between the cut and the depth: 40/20 = 2. *When this is done, the result is always in points and bars rather than in bars and points. Therefore, the taper is 2 points to 1 bar.*

OTHER PROBLEMS AND SOLUTIONS

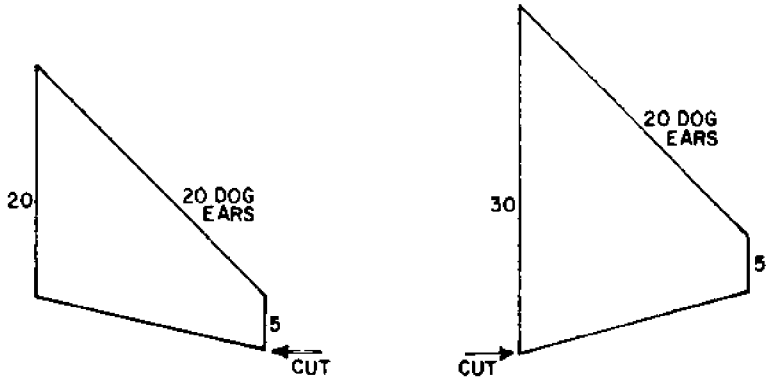


FIGURE 11. Two pieces of twine with different dimensions but the same taper proves the importance of knowing where to start the taper. As stated in the text, the beginner should always cut from the wide end, which is determined by adding the number of dog ears to the intended narrow end. If this is greater than the intended wide end, then the cut should start as indicated in the left drawing. If the opposite is true, then the taper should start as indicated in the right drawing.

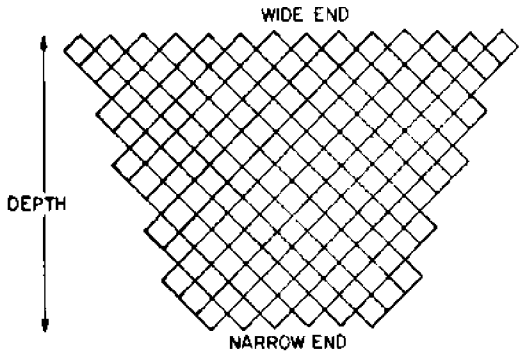


FIGURE 12. Belly or square with dimensions of 14 x 6 x 9 deep. This body cut shows 2 bars, 1 point, then 1 bar, 1 point.

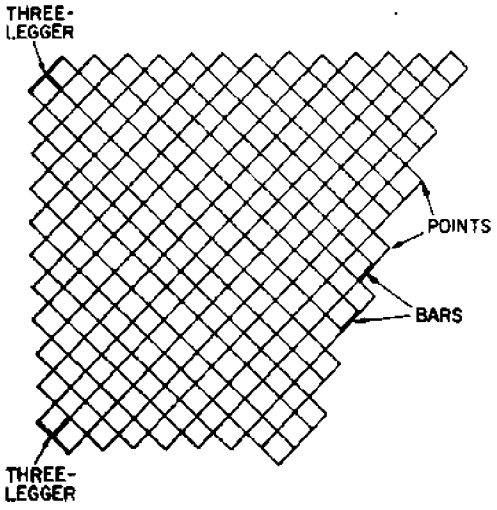


FIGURE 13. Half belly. When a single belly or square is to be cut, caution must be taken. Note that the three-leggers are on the half belly as shown; therefore, the other half must not have any three-leggers. Should this mistake be made, it can be corrected by cutting off a half mesh starting on one three-legger and ending on the selvedge. In order to sider two pieces of twine together, there must be a three-legger on one piece to start and on the other piece to end.

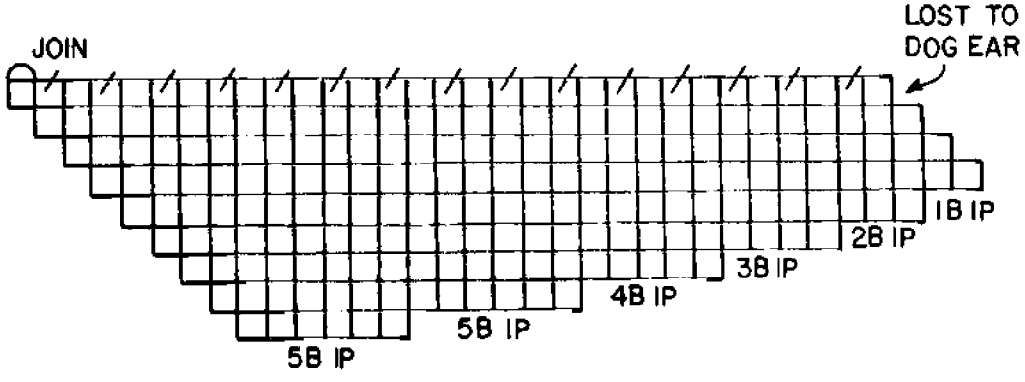


FIGURE 14. Wing before the dog ears are knit on. Cut bars starting between bar 1 and 3 as shown. Join the needle at the first point. This will leave the required three-legger in the proper position. A taper cut by guess may look like that shown above, or be even worse. The proper taper should be 3 bars to 1 point, 3 bars to 1 point, and 4 bars to 1 point repeated until the taper is completed.

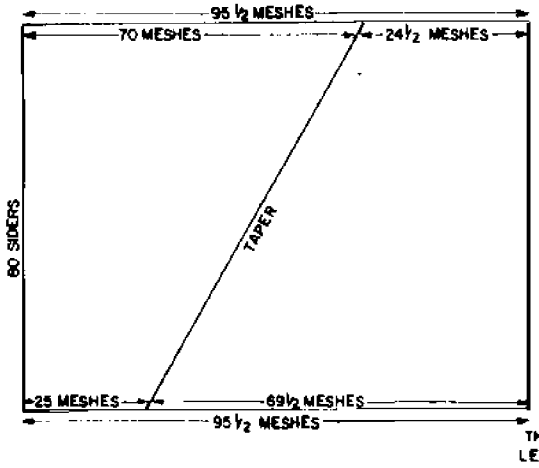


FIGURE 15. One belly or one square example. Using the formula 2c/d-c, a total of 95½ meshes will make a belly with dimensions of 140 x 50 x 80. Note that the 95 meshes are half of the wide end plus half of the narrow end. The half mesh is gained when the two halves are sidered together. One square is cut the same way. Remember to *always use total dimensions whenever you figure a taper.* Refer to caption, Figure 14, for position of three-leggers.

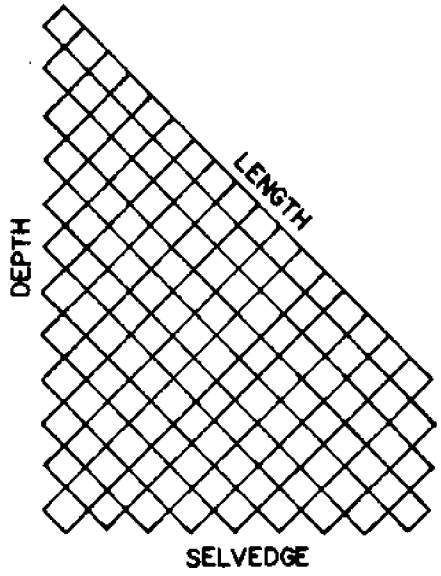


FIGURE 16. Straight bar top wing with dimensions of 12 x 4 x 16 bars. A standard top wing has no taper on the selvedge. However, if a wing needs to be longer than the depth, the lower wing taper formula should be used

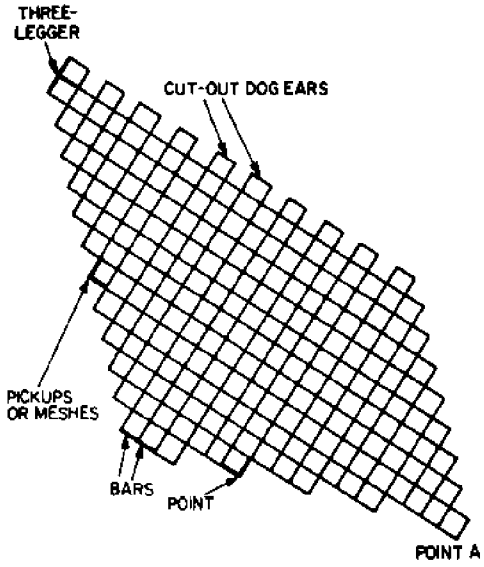


FIGURE 17. Tapered wing with dog ears with dimensions of 12 x 8 x 10 dog ears and a taper of 2 bars to 1 point. Note that only a single three-legger is left on all dog ear wings. The other one is on the taper at Point A and will be taken up when the net is laced. The narrow end of all wings should have double meshes. This can be done by cutting off a half mesh and knitting it back with a double needle or going over the mesh with a single needle.

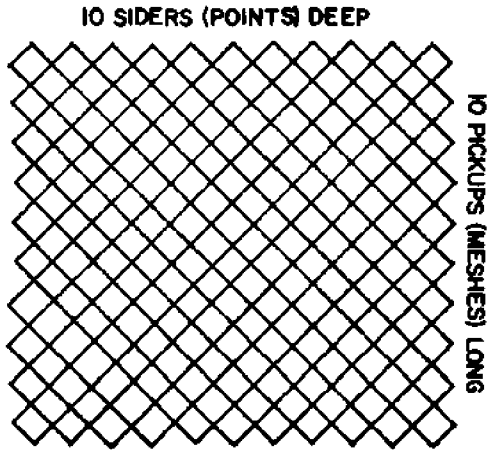


FIGURE 18. Square piece of web showing pickups and siders. In all tapers we call the siders *points* and the pickups *meshes*. The knots can and should be removed from the pickups, but they cannot be removed from the siders. The pickup, or mesh side, however, should be cut with a sharp knife. Cut one strand only and pull the mesh; the knot will fall off. (The best tool for cutting new web, by the way, is a soldering gun with a cutting tip. This tool welds the ends and prevents fraying.)

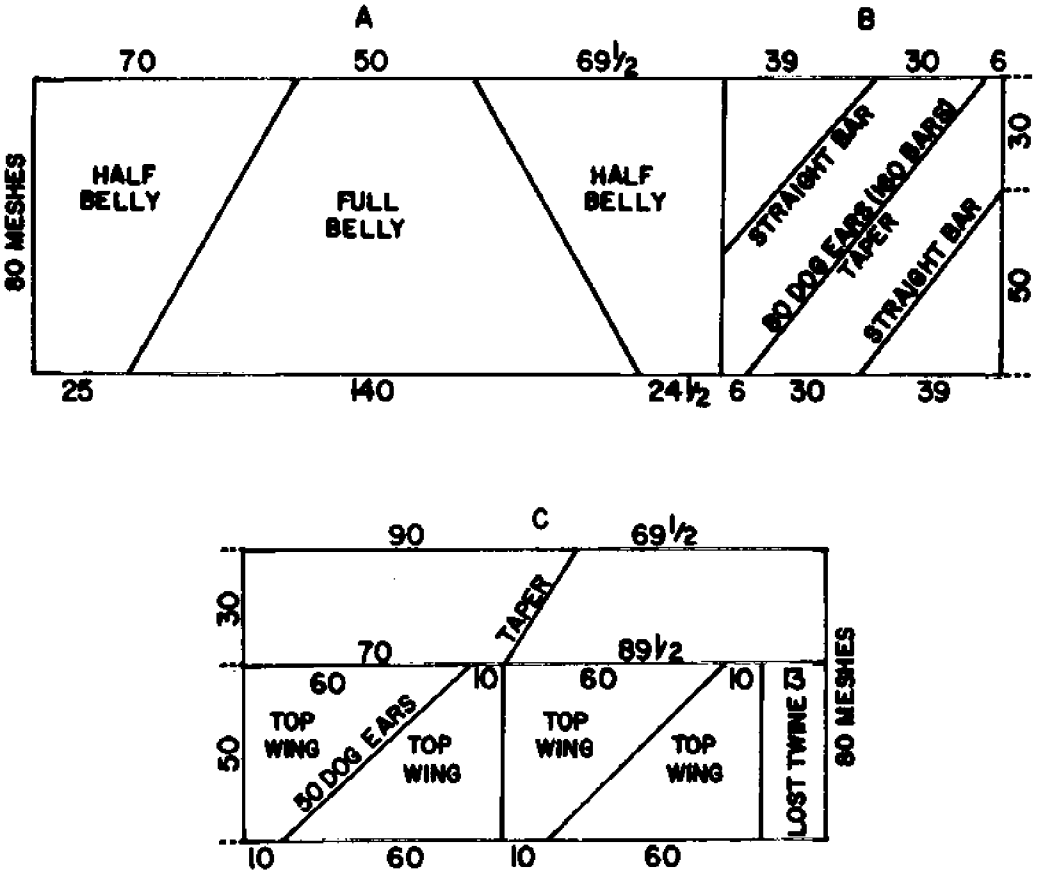


FIGURE 19. Cutting diagram for complete net plus two extra top wings. Part A shows that a total of 190½ meshes is required for two bellies. (Two meshes are lost on each pair of bellies.) In Part B a total of 78 meshes is required to make one pair of lower wings, while in Part C a total of 144 meshes is required to make four top wings, and 160 meshes to make one square. Wasted twine for the complete net totals only 13 meshes.