Tour Stop #7: Estimating Irregularly Shaped Areas for Improved Pesticide and Fertilizer Applications

The first step toward making a precise application of a cultural input is to estimate the land area to which the application is to be made. All other factors being equal, the more accurate your estimation, the more precise will be your application. If your sports fields are long rectangles, your tees are boxes, your greens are circular, or your grounds are formally laid out, then plane-geometry formulas are all that are needed. However, it's the irregular shapes more commonly found in informal landscapes, golf course fairways, and localized, site specif areas that create the greatest challenges in terms of area estimation. Think about the juxtaposition of shapes that occurs with localized dry spots on a football field.

So by what methods, old and new, can one estimate the size of these areas? Keep in mind that they are all approximations. The most precise way (and the oldest) starts by encompassing the irregular area within coordinated grids. To demonstrate this, I outlined such an area of turf as depicted by Figure 1 shown below. Then string and nails were used to structure a coordinated grid system of squares 9 ft by 9 ft each (see Figure 3). For each square, the percentage covered by the area in question was estimated and recorded.

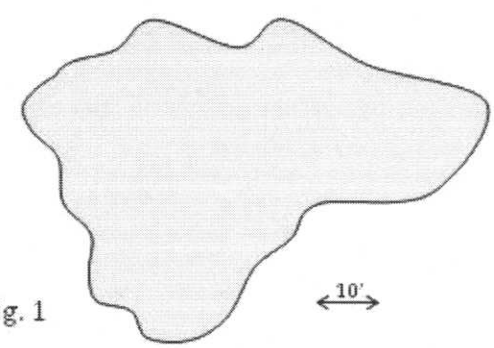


Fig. 1

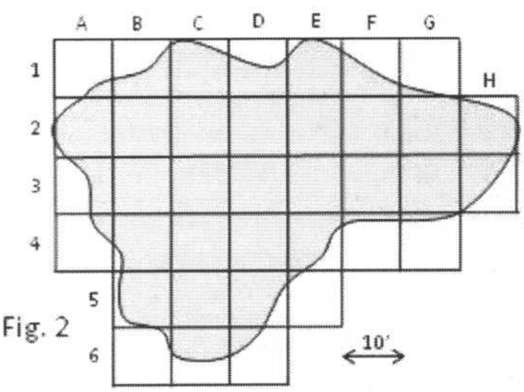


Fig. 2

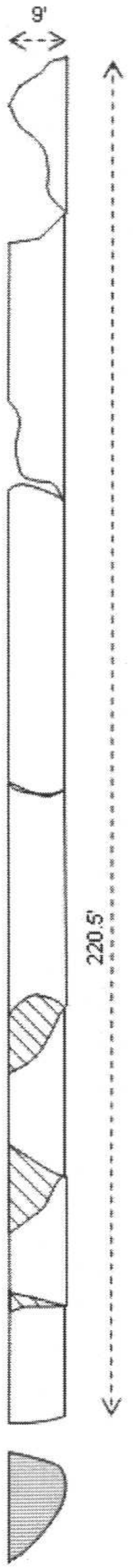
Using a spreadsheet the overall area was totaled to be 2057.4 ft^2 as shown in Table 1. If the gridlines are laid out closer together, the more precise (and laborious) the process becomes. Figure 3 depicts squares 3 ft x 3 ft and Table 2 shows the percent coverage of each grid and the summated area of 2,065.2 ft^2, which is as close as I care to get.

Table 1

Values are estimated percent coverage of each 9' x 9' grid.

	A	B	C	D	E	F	G	H
1	15	60	95	65	95	48	10	
2	90	100	100	100	100	100	98	70
3	42	100	100	100	100	100	98	42
4	10	100	100	100	65	8	5	
5		80	100	80	2			
6		2	45	15				

Sum (A1:G8) = 2540%   81 ft^2 x 25.4 = 2057.4 ft^2



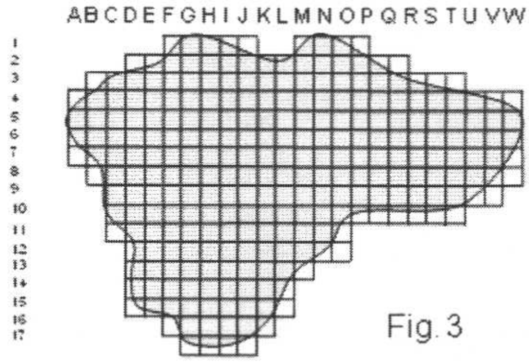


Fig. 3

Table 2.

Values are estimated percent coverage of each 3' x 3' grid.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
1						30	35	32	50	15			50	100	75	15								
2				10	30	90	100	100	100	100	80	75	100	100	100	95	45	3						
3		20	80	100	100	100	100	100	100	100	100	100	100	100	100	100	90	80	50	15	5			
4	35	90	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	90	20	50	20
5	35	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	35
6	60	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	80
7	5	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	35
8		10	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	50	
9		5	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	5	2	
10			85	100	100	100	100	100	100	100	100	100	100	100	100	35	20	20	20	20	5			
11			8	100	100	100	100	100	100	100	100	100	100	100	20									
12				55	100	100	100	100	100	100	100	100	97	50										
13				65	100	100	100	100	100	100	100	100	25											
14				60	100	100	100	100	100	100	100	100	45											
15				20	80	95	100	100	100	100	100	5												
16						10	100	100	100	100	20													
17							35	55	45	15														

Sum(A1:X17) = 22,947% $9\ ft^2 \times 229.47 = 2065.2\ ft^2$

The time-proven (and much more practical) way of doing this is to employ the Offset Lines Method. On the same turf area, I marked points on the opposite extreme edges and measured the distance to be 72 ft as shown in Figure 4 below. As closely as possible, this longitudinal axis is then divided into even increments. In this case, eight segments that are each 9 ft in length. The next step is to measure the perpendicular side-to-side distances between each segment. Then you simply sum the total of these offset lines and multiply them by the distance between each line. Figure 4 shows what these segmented areas look like when stacked upon each other. So in essence, a long skinny rectangle is being measured. What about the last piece, whose common border length has already been used? Well, you can think of that piece (and the cross-hatched overlaps) being used to fill in the open areas of the rectangle. In this example, the Off-Set Line Method estimates an area of 1998 ft^2, which is within 3.3% (smaller) of the more precise area calculation explained above.

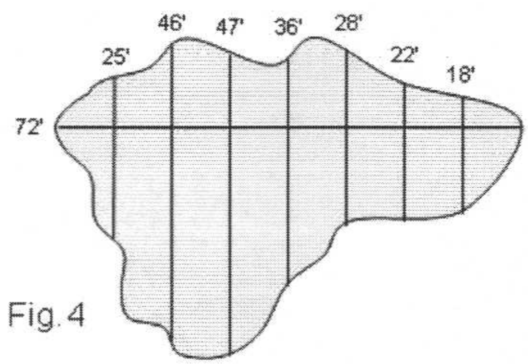


Fig. 4

Distance between offset lines= 72'/8 segments= 9 ft
Sum Offset Lines= 25 + 46 + 47 + 36 + 28 + 22 + 18 = 222 ft Estimated Area = 222' x 9' = 1998 ft^2

Fig. 5

As with the Coordinated Grid Method, the more interceptors, the closer is your estimate to the true area. Of course the opposite is also true. With our example, I have reduced the number of offset lines from seven down to two (segments from eight to three) as shown in Figure 6. The estimate now becomes 1752 ft^2, which could lead one to believe that area is about 15% less than it actually is.

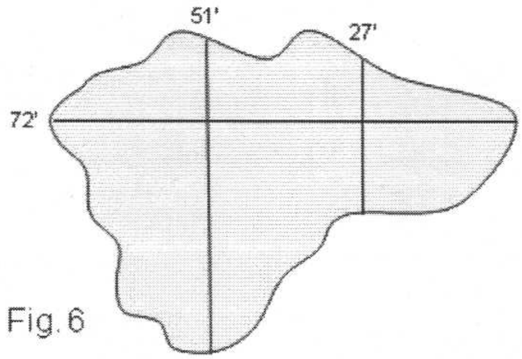


Fig. 6

Distance between offset lines = 72'/3 segments = 24 ft
Sum of offset lines = 49 + 24 = 73 ft
Estimated Area = 73' x 24' = 1752 ft^2

While it appears that you could also take the average of the offset lines shown in Figure 4 and multiply it by the longitudinal axis length, in this case, this results in a grossly overestimated area of 2283 ft^2 (31.7' x 72'), or a error of greater than 10%. Being able to give a good explanation for this has eluded me so far.

What about using GPS technology to login way points? First of all recreational receivers are accurate only to within a few meters at best. While this can help you find your hunting stand or the nearest gas station, you would need a professional unit costing around $1500 to accurately measure irregular turf and landscape areas. Even then you could have trouble on the north sides of buildings or under thick canopied trees where the sight lines to one of the GPS satellites could be obstructed. On the other hand, sophisticated, ground-based surveying equipment costing around $10,000 would enable you to accurately measure any irregular area.

An intriguing new method utilizes Google Maps to outline areas within satellite images. Freeware is available that does this and then gives you an estimate of area in square meters, acres, and square kilometers. This could be especially useful for larger irregular areas such as golf course fairways and parklands. These would also be areas where the satellite values could be compared to estimates found by using traditional methods shown in this article.

David Gilstrap, Ph.D.
Senior Turf Specialist
Michigan State University

<u>NOTES</u>