Ham 148 - Antenna resonance bandwidth

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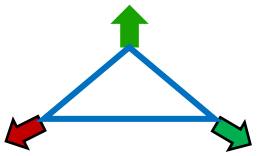
A few definitions are in order.

- *Antenna*: a conductive material, usually metal, that converts electrical energy from a circuit to electro-magnetic energy in space.
- *Resonance*: the frequency of two devices are the same. Specifically, the natural frequency of the antenna matches the tuned frequency of the radio. If not tuned (resonant) the radio does no work properly.
- *Bandwidth*: the range of frequencies that reasonably match the natural frequency. Generally, the range of frequencies resulting has low SWR, less than 1.5:1. In some cases the bandwidth can be stretched to 2:1 SWR.
- *Q*: a quality factor, whatever that means. High Q means sharp-cutoff of frequencies, resulting in low bandwidth. Q represents a percentage change or variation from the resonant frequency. A typical value is 1%. Less means very directional, sensitive response, which communicates with few signals.

$BW = f_o * Q$

A quote from a SteppIR ad is very informative.
"Yagi antennas are basically single frequency devices that work well only over a very narrow range, typically 0.5% change in frequency. Fixed length yagis compensate by using a variety of techniques, all of which result in serious degradation of performance, especially in Front to Rear rejection, and added complexity, size, and weight. Dipoles have a much broader bandwidth but still cannot cover the entire 80m and 40m bands and maintain a low SWR (<1.5:1)…(We seek) desired frequency with none of the compromises in performance that all fixed antennas require."

"**Faster, cheaper, better**."
You can have any two, but not all three. Engineering is the trade-off of 'time, cost, and quality."
All antennas (radios) are a trade-off.
You must decide what properties you want and what you are willing to dispense.


Energy trade-offs

Size matters. A much smaller physical size (antenna aperture) is not as effective.
The size cannot touch as much of the wave. Nevertheless, smaller antennas can locate in more places.
A 1, 2 or even 6 db less (1 S-unit) antenna is still effective, if the signal is above the noise level.

Vertical antennas are used for most close-in emergency communications, which includes inclement weather.
A vertical 10-meter dipole is 16-feet long. With a 12-ft feed-point, the top of the antenna is 20'.
That requires supports, lightning protection, and HOA approval.
A triad is only 50" tall and has less than 0.4 dB lower signal. Which makes sense in more conditions?

Band m	Freq MHz	BW kHz
80	3.9	39
40	7.2	72
10	29	290
6	51	510
2	145	1450

If signal strength is not a serious issue, what is the trade-off?

Bandwidth is the resonant frequency multiplied by the quality factor, typically a percent like 1.0%.
High frequency will have greater bandwidth, while 4 MHz has a very skinny bandwidth of 40 kHz.
For this reason, sharply resonant, tunable-loaded-inductors like ham-stick have a narrow bandwidth.

In comparison, a dipole on 80m with a 1.5:1 SWR is only 100 kHz. That is still not great, but some wider.

Most local communications invoke vertical antennas. If the other antenna is horizontal, the small intersection of waves theoretically transfers zero energy.
In the real world, it causes about 18 dB signal drop.
If one of the antennas is very high, a drop in signal may not be noted.
Waves reflected off the ionosphere become elliptical, so there is no loss between vertical and horizontal.

Bandwidth of an antenna determines how many frequencies can be tuned. A narrow bandwidth requires retuning by physically readjusting the length or by tuner compensation.

The triad antenna uses a vertical radiator, a 45-degree droop return, and a complementary 45-degree droop counterpoise. It has an SWR near 1.02:1.
Bandwidth can usually be widened by setting the return and counterpoise to slightly different frequencies either side of the radiator frequency.
Tune the radiator and return to the desired frequency.
Make the return shorter and the counterpoise longer.
That allows the radiator to match either droop element.

Life is good. Enjoy!